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HUMAN CAPITAL, BONUSES, COMPENSATING DIFFERENTIALS AND
AIR FORCE PILOT RETENTION

Stephen Paul Barrows

A Dissertation
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the Graduate Faculty of
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DISSERTATION ABSTRACT

HUMAN CAPITAL, BONUSES, COMPENSATING DIFFERENTIALS
AND AIR FORCE PILOT RETENTION

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The Air Force spends millions of dollars each year to train its pilots. Upon completion of pilot training, an Air Force pilot has acquired skills which are very marketable in the civilian airlines. Because of this, the Air Force imposes an active duty service obligation on each of its pilot training graduates. When this service obligation expires, many pilots separate from the service to pursue lucrative careers with the civilian airlines. The Air Force has an incentive to know what factors induce pilots to separate from the service so they can respond as manpower requirements necessitate.

The purpose of this dissertation is to examine the determinants of pilot retention and to estimate compensating differentials to stabilize retention rates across various Air Force aircraft categories. To provide the appropriate historical, institutional, and theoretical background, Chapter 1 examines the Air Force's compensation system in light

of the economic theory of internal labor markets. Chapter 2 reviews the economic theory of human capital and its relationship to turnover. Using individual data provided by the Air Force Personnel Center and other sources, several logistic regressions and linear probability models are run to estimate the relationship between human capital, pilot salary bonuses, and a pilot's stay or leave decision. The results of the regressions are typically consistent with the economic theory of human capital and demonstrate that pilot bonuses are very effective in inducing pilots to remain in the Air Force. Chapter 3 explores the economic theory of hedonic pricing models and compensating wage differentials. Using attrition rates as a proxy for job dissatisfaction, a model is built to estimate compensating differentials required to maintain stable retention rates across various aircraft categories. Additional models are built to estimate how much additional money is necessary to compensate pilots for various disagreeable job characteristics. Some job characteristics, such as the military operations tempo, require substantial additional compensation whereas other characteristics, such as unsafe aircraft, require virtually no additional compensation to induce pilots to remain in the service. Chapter 4 summarizes the results of the previous three chapters and offers a conclusion and recommendations.

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CHAPTER 1: HISTORICAL AND INSTITUTIONAL ANALYSIS

1.1 Introduction and Literature Review

Air Force pilot turnover has been particularly high in recent years. Retention rates dropped so precipitously that Congress recently authorized doubling the size of Air Force pilot bonuses just to stop the hemorrhaging. Low retention rates imply that the Air Force is not offering a competitive wage; pilots are finding better opportunities in other occupations, especially in employment with the civilian airlines. There are numerous studies addressing the economics of labor retention and turnover in general, and there are several analyses of the problem of Air Force personnel retention specifically. The economic analysis of pilot retention is inextricably linked to the economics of labor compensation. Asch (1993) has surveyed the economics literature and pointed out how economic theory applies to designing an efficient military compensation system. Her survey reveals how broad the relevant economic issues are. Among the pertinent economic issues that Asch identifies are the economics of internal labor markets, industrial organization, imperfect and asymmetric information, moral hazard and adverse selection, risk aversion, efficiency wages, tournament theory, human capital theory, and the economics of retirement pay. Indeed, these are but a few of the economic issues pertinent to labor turnover in general, and Air Force pilot retention specifically.

Clearly not all the economic issues relevant to Air Force pilot retention can be addressed in this dissertation. Instead, this dissertation expands upon previous research by: (1) elaborating on the historical and institutional economic issues relevant to Air Force pilot retention, (2) conducting an econometric analysis of pilot retention to show how human capital and pilot bonuses impact retention rates, and (3) estimating compensating wage differentials for variations in human capital and job attributes. This dissertation concludes with recommended changes to the current compensation structure in order to achieve hypothetical targeted retention rates. The remainder of this chapter begins by reviewing the literature relevant to the broader issue of military compensation and personnel retention. It then provides the details of the institutional economic issues pertinent to pilot retention. It focuses on the historical background of pilot compensation and the economic theory of internal labor markets. Chapter 2 reviews the theory of labor turnover, and examines how turnover is related to human capital and salary bonuses. Following this theoretical overview, Chapter 2 uses econometric models to demonstrate how human capital and bonuses affect retention rates. Chapter 3 provides the theoretical background of compensating wage differentials and hedonic pricing models, and applies these theories to estimate steady state retention rates for all military aircraft categories.

1.2 General Literature Review

As Asch (1993) explains, there are many economic issues pertinent to military compensation and employee turnover. The RAND Corporation has studied each of these aspects of military manpower in depth. For example, there has been research addressing

labor demand (i.e., pilot manpower requirements) and personnel inventory maintenance (Thie et al. 1995), as well as research identifying the strengths and weaknesses of the current military retirement system as a manpower management tool (Asch and Warner 1995; Asch and Warner 1999). An excellent survey of the economics of military manpower is found in Warner and Asch (1995). Additionally, Asch and Warner (1994) develop one of the most detailed and rigorous economic models of military compensation. By using an explicit mathematical framework which models individual retention and labor supply decisions, Asch and Warner explain how policy decisions affect individual labor supply choices and recommend changes to the current military compensation system.

Additional research has been specifically targeted to the analysis of Air Force pilot retention. Stone, et al (1998) provide an excellent literature review of previous studies and use a logistic regression of their own to analyze the probability of a pilot continuing in the Air Force. Most recently, research addressing the current low pilot retention rates is found in Taylor, Moore, and Roll (2000), and Fullerton (2000).

The military retirement system is another important compensation component which has significant implication for long-run retention policy. Numerous criticisms have been made about the military retirement system and several recommended changes have been offered. One of the most common criticisms is that individuals who retire prior to 20 years of service receive no benefits. This 20-year vesting is a crucial factor in the stay or exit decisions of mid-level officers (e.g., with 8 to 15 years of service). Several studies have examined and analyzed alternatives to the current system in light of

personnel retention. Among them, the RAND corporation has published two important studies by Asch and Warner (1994) and Asch, Johnson, and Warner (1998). In the former study, Asch and Warner examine the possibility of vesting at 15 years of service instead of 20. They conclude that not only would such a system be “highly costly and inefficient” it would also “have a perverse effect on officer retention” (Asch and Warner 1994, xiii, 54-57). Asch, Johnson, and Warner examine the effects of converting the current military retirement system into one similar to that used for civilian federal employees. This system requires mandatory retirement contributions by employees. In their model, they couple this system with an across-the-board pay increase for military members. They find that changing the current military retirement system to a system similar to the one used for civilian federal employees would only be an improvement if it is “coupled with a skewed pay raise” where individuals in higher military grades receive larger pay increases than those in lower grades (Asch, Johnson, and Warner 1998, v, 45-50). These studies on military personnel turnover, military compensation, and the military retirement system all make use of economic theory to recommend changes in the military compensation system. This dissertation makes an additional contribution to this literature.

1.3 History of Military Compensation

The compensation of any military pilot is established by law and follows a simple structure. Consider the typical pilot in 2002 with nine years of service (YOS) facing his initial retention decision point. As a captain with dependents, he receives \$48,841 of

base pay, a housing allowance of \$9,155, a subsistence allowance of \$1,996, and \$7,800 for being a pilot with more than six years of aviation service for a total annual monetary compensation of \$67,792 (Defense Accounting and Finance Service, n.d.).¹ Additionally, the pilot might also be eligible for a pilot bonus or hostile fire pay. The military has followed this compensation pattern for years: base pay, allowances, and special duty pay.

Special duty pay is a particularly important component of compensation for military aviators, and has an interesting historical development. From the beginning of military aviation, military pilots have received special compensation for flying. The advent of military aviation brought its own unique hazards during peacetime and war. Initially, pilots were given an additional 35 percent above military base pay as compensation because of the special dangers associated with flying (Office of the Secretary of Defense² 1996, 197). During World War I, this additional pay ranged from 25 percent to 75 percent above base salary for Army Aviators (OSD 1996, 197). From the 1920s through World War II, all military aviators received the same pay incentive: 50 percent above base pay (OSD 1996, 197). While from the beginning of military aviation this special flight pay was justified as compensation for hazardous duty, this justification changed at the beginning of the Cold War. In 1948, the Department of Defense reviewed the entire military pay system and concluded that special pays and bonuses should be used by the military as a manpower tool to adequately meet the military's demand for labor in particular occupational specialties (OSD 1996, 198). One of the pays authorized

¹ Henceforth DFAS. This does not consider the tax advantages of the allowances; subsistence and housing allowances are not taxable income. Military pay tables were taken from the internet: <http://www.dfas.mil/money/milpay/>

² Henceforth OSD.

was flight pay. This flight pay was a precursor to today's flight pay and continued until 1974 when Congress passed the Aviation Career Incentive Act. This Act established a special pay called Aviation Career Incentive Pay (ACIP) and this is the special flight pay used today (OSD 1996, 202). Essentially, ACIP provides additional compensation to military pilots because of the higher relative demand for their skills in the civilian labor market compared to other officers.

As part of the National Defense Authorization Act of Fiscal Year 1989, the Congress authorized the payment of additional retention bonuses to Air Force pilots. This bonus, known as Aviator Continuation Pay (ACP), initially authorized up to \$12,000 for each year that a pilot agrees to remain on active duty through 14 years of commissioned service (OSD 1996, 233). Recently, bonuses have increased to a maximum of \$25,000 annually for each year a pilot agrees to remain on active duty. The amount of the bonus received is a function of how many years the pilot agrees to remain on active duty. The shorter the contractual commitment, the smaller the bonus is. Historically, the targeted group has been those pilots between 6 and 14 years of commissioned service. It is during this career timeframe that the service commitment a pilot incurs from pilot training typically expires and he first becomes eligible to separate. The offered bonus has been as low as \$6,000 for a 12-month contract and is currently as high as \$25,000 annually for pilots with less than nine years of service who agree to remain in the Air Force through their fourteenth year of service.

Another significant component of the military compensation system is the retirement pay system. It is also an important retention tool. The military retirement

system is designed to reward individuals for remaining in the service for at least 20 years. Those currently in the military may fall under one of three systems. All three systems require 20 years of service in order to earn a military retirement pension. The details of each system are as follows (OSD 1996, 564). The first system, which will be referred to as the original system, applies to those individuals who entered the service prior to September 8, 1980. These military personnel earn monthly retirement pay at a rate of 2.5 percent of their final monthly base pay, times the number of years of military service they have at retirement ($.025 \times \text{YOS} \times \text{BASE}$). The second system applies to those individuals who entered the service between September 8, 1980 and July 31, 1986. These individuals also receive retirement pay at a rate of 2.5 percent times their number of years of military service, but it is calculated on the basis of the average of the highest 36 months of their base pay ($.025 \times \text{YOS} \times \text{High-3}$). The effect of this system is a reduction in retirement pay: viz., average base pay during a serviceman's final three years of service is typically lower than his base pay immediately preceding retirement, due to periodic raises for longevity. This system is known as the "High-3" system. Finally, the most recent system applies to individuals who entered the service after July 31, 1986. These individuals fall under a system established by the Military Retirement Reform Act of 1986 known as the REDUX system. Under this system, individuals receive 2.5 percent times their military years of service of their highest 36 months of base pay (i.e., High-3), minus 1 percent for each year of service less than 30 years ($(.025 \times \text{YOS}) - (.01 \times (30 - \text{YOS})) \times \text{High-3}$). Hence, a person retiring under this system with 20 years of service receives 40 percent of the highest 36 months of base pay. Under each system, a

maximum of 75 percent of basic pay is paid as a retirement pension (.025 x 30YOS).

Another important change mandated by the REDUX system is its adjustments for inflation. While the original and High-3 systems gave an annual cost of living adjustment (COLA) equal to the consumer price index (CPI), the REDUX system adjusts by the CPI minus 1 percent. Both this lag in the COLA adjustment, as well as the 1 percent “penalty” for each year of service less than 30 years, are eliminated at age 62, and the High-3 system is restored for those in REDUX (OSD 1996, 564).

The National Defense Authorization Act of 2000 provided a new option for those individuals under the REDUX system. These individuals are given a choice at their fifteenth year of service: remain in the REDUX system and receive a \$30,000 career status bonus, or forego the bonus and revert back to the High-3 retirement system (OSD, n.d.).³ Table 1 below provides a summary example of a Colonel⁴ retiring at the completion of 22, 26, and 30 years of service (assuming constant dollars using the 1999 pay scale) under the three different systems:

Table 1.1: Monthly Retirement Pay Rates

	22 Years of Service	26 Years of Service	30 Years of Service
Original	Final Basic Pay ⁵ : \$6,172 Retirement Pay: \$3,394	Final Basic Pay: \$6,694 Retirement Pay: \$4,351	Final Basic Pay: \$6,694 Retirement Pay: \$5,020
High-3	Final High-3 Avg: \$5,805 Retirement Pay: \$3,193	Final High-3 Avg: \$6,326 Retirement Pay: \$4,112	Final High-3 Avg: \$6,694 Retirement Pay: \$5,020
REDUX	Final High-3 Avg: \$5,805 Retirement Pay: \$2,728	Final High-3 Avg: \$6,326 Retirement Pay: \$3,859	Final High-3 Avg: \$6,694 Retirement Pay: \$5,020

³ <http://militarypay.dtic.mil/actives/retirement/ad/index.html>

⁴ Assumes the individual is promoted to Colonel no later than 19 years of service.

⁵ Assumes the individual's final basic pay is at the rate of 22+, 26+, and 30+ years of service.

As mentioned above, the retirement system is an important factor in the retention decisions of military personnel, and clearly its impact varies depending upon which system applies.

In addition to the monetary compensation, military officers receive numerous non-wage benefits. These include 30 days of paid leave every year regardless of rank, commissary and base exchange privileges (where sales tax is not imposed), free dental and medical care, a variety of morale, welfare, and recreation (MWR) activities (e.g., golf courses, bowling alleys, Officers' Club), and family support programs. The military clearly has a very generous leave program compared to most civilian firms. Depending upon each family's health situation, the medical and dental privileges can be highly beneficial. Among other purposes, the MWR and family support programs exist to ease family hardships when military members are deployed, to ease the transition from assignment to assignment, and to provide recreational outlets in remote locations (Buddin 1998, 3). As with any non-monetary benefits, the marginal rates of substitution between one of these benefits and a dollar increase in monetary salary will vary from individual to individual. Nevertheless, they are a significant component of the entire compensation package for military officers.

1.4 The Air Force and Institutional Economics

One area where the economic theory sheds light on military compensation and pilot retention is the internal labor market (ILM) literature. The theory of ILMs draws attention to the unique institutional factors found in labor markets. As an institution, the

Air Force possesses many characteristics which sharply distinguish it from a typical firm in the free market. Three characteristics immediately come to mind. First, the Air Force is not driven by a profit-maximizing or cost-minimizing motive. Rather, as an institution, it is most accurately described as a bureaucracy (Mises 1983)⁶. Hence, while individual pilots engage in economic calculation based on their own self-interest, Air Force policy makers are obliged to make decisions based upon service regulations and within a given budget. Second, the Air Force employs an unusually large number of people compared to private firms. Third, the Air Force has the legal authority to bind the labor of its military employees. Such important differences necessitate an examination of Air Force pilot retention from an institutional economic perspective. This chapter posits that although the Air Force's internal labor market may be the most efficient institutional form for achieving its objectives (viz., national defense), its ILM structure cannot shield its personnel from the forces of the external labor market. Instead, the Air Force must compete for the services of its pilots like any other firm through the use of wages which adapt to market forces. Before demonstrating this, it is first necessary to briefly review the economics of the firm.

When students of production theory learn about the firm, the analysis is usually reduced to a production function where output is mathematically described as a function of a mixture of inputs. Little explanation of what the firm is and why it exists beyond this technical approach is offered. Many practical considerations such as labor contracts,

⁶ Mises provides a thorough analysis of the differences between profit management and bureaucratic management and the perverse consequences often arising from the latter. He elaborates: "Bureaucratic management means, under democracy, management in strict accordance with the law and the budget" (47).

transactions costs, the heterogeneity of capital equipment, organizational structure and size, are initially ignored. When the firm is represented merely as a production function, the question still arises: Just what exactly is the firm? In his 1937 essay, Ronald Coase answered this question and chartered a course for future research on the firm. His essay served as a catalyst for the field of industrial organization.

Coase described the purpose of his essay on the firm as follows: “Our task is to attempt to discover why a firm emerges at all in a specialized exchange economy” (Coase 1937, 390). Coase explains that a firm arises in the marketplace as an efficient mechanism for organizing production. There are costs associated with organizing. One could organize production through the use of spot-market exchanges on a day-to-day basis. But such daily negotiating and contracting would be very costly and filled with uncertainty. Contracts require clauses for contingencies. The more contingencies are outlined in a contract, the more costly it will be to negotiate. Coase’s assertion is that the firm arises as an alternative to repeated contracting in such spot-market exchanges (ibid, 390-391). Ultimately, an entrepreneur reduces the transaction costs associated with organizing by internalizing these contracts (ibid, 392-393). This internalization of contracts constitutes a firm where the factors of production agree, “to obey the directions of the entrepreneur *within certain limits*.” (ibid, 391).⁷ The firm grows in size until the marginal cost of organizing is equal to the marginal benefit of reducing transaction costs in the open market (ibid, 395). As one pair of economists has summarized: “Coase’s penetrating insight is to make more of the fact that markets do not operate costlessly, and

⁷ Italics in the original.

he relies on the cost of using markets to *form* contracts as his basic explanation of the existence of firms” (Alchian and Demsetz 1972, 783).⁸ Since the publication of Coase’s paper, economists have examined the firm in much greater detail.

Following Coase, much of the research has focused on the cost-minimizing aspects of the firm as a means of economic organization. For example, Alchian and Demsetz (1972) seek to explain the internal structure of the firm and to identify the conditions where a firm is more efficient than cooperative production across markets (Alchian and Demsetz 1972, 777). The principal insight of these two economists was to point out the inefficiencies associated with shirking, and how the firm mitigates such opportunistic behavior by laborers. They argue that when output is the result of team production, opportunistic individuals will be tempted to free ride off the productive efforts of their teammates. In response to this problem, the firm arises to monitor the inputs. According to Alchian and Demsetz, “The monitor earns his residual through the reduction in shirking that he brings about...” (ibid, 782). Hence, the firm also arises in the marketplace to reduce shirking and improve team production. This insight complements the theory of the firm first posited by Coase. More recently, Williamson (1975, 1981) has made significant contributions to the theory of the firm. Like Coase, Williamson emphasizes transaction costs in his analysis of the firm. Because there are numerous transactions costs associated with recruiting, training, and retaining Air Force pilots, Williamson’s contribution is particularly pertinent to an analysis of Air Force pilot retention.

⁸ Italics in the original.

Williamson's analysis of the firm differs somewhat from the common, neoclassical approach to the firm. He summarizes the distinction between his approach and the more common neoclassical approach as follows:

The two behavioral assumptions on which transaction costs analysis relies that both add realism and distinguish this approach from neoclassical economics are (1) the recognition that human agents are subject to bounded rationality and (2) the assumption that at least some agents are given to opportunism. (Williamson 1981, 553)

Hence, the chief goal of the firm is efficient production through the minimization of transaction costs. Every managerial method used by the firm (e.g., efficiency wages, job ladders, and internal labor markets) can be interpreted as a means to minimize transaction costs. Additionally, Williamson's remarks are important because both pilots and Air Force managers are subject to bounded rationality and some degree of opportunism. Indeed, without these factors there would be no need for the Air Force to impose upon its pilots an active duty service obligation upon completion of pilot training. Furthermore, pilot bonuses reflect an effort to reduce transaction costs: retain more pilots in order to reduce the costs incurred to train replacements. With this background on the firm in mind we now turn to a discussion of internal labor market theory.

Thus far it is evident that the firm is essentially an institution designed for efficient production. To minimize cost, entrepreneurs can organize the firm in many ways. One such organizing mechanism is the internal labor market (ILM). The ILM is broadly defined by Doeringer and Piore (1971) as "an administrative unit, such as a manufacturing plant, within which the pricing and allocation of labor is governed by a set of administrative rules and procedures." (Doeringer and Piore 1971, 1-2). The ILM has

several identifying marks which distinguish it from the external labor market. These identifying marks include ports of entry and exit, job ladders, and “implicit and explicit rules governing wages, hours of work, promotion opportunities, and grievance procedures” (Wachter and Wright 1990, 240).⁹ This stands in contrast to the complete theoretical flexibility of wages, hours, and labor mobility of standard neoclassical labor market analysis. The key distinction between the ILM and neoclassical labor market analysis is rigidity versus flexibility. As Doeringer and Piore note:

But the utility of the internal labor market as an analytical construct does not depend upon the existence of administrative rules. It depends rather upon the *rigidity* of the rules which define the boundaries of internal markets and which govern pricing and allocation within them. If these rules are not rigid and respond freely to variations in economic conditions, their independent economic role will be minimal. (Doeringer and Piore 1971, 5)¹⁰

At first glance, these descriptions of ILMs appear to imply that ILM theory is incompatible with neoclassical economic theory where the price and allocation of labor are determined by the laissez faire market process. In fact, while ILM theory makes important distinctions between internal and external labor markets, they need not be incompatible, as we will see.

Although there are sociologically important aspects of internal labor markets that are raised by institutional economists (some of which are relevant to the military), this chapter focuses on the efficiency aspects of them. Internal labor markets can structure job ladders and pay scales in a way that seeks to maintain an optimum level of turnover (Wachter and Wright 1990, 245).

⁹ See also Doeringer and Piore, 2-3.

¹⁰ Italics in the original.

Previous research has demonstrated that a pay scale in an internal labor market can be structured in such a way that it creates a wedge between the marginal revenue product of an individual's labor and his wage. Such a wedge is not uncommon. For example, Oswald (1984) demonstrates that the existence of an internal labor market alongside a competitive external labor market (ELM) causes junior ILM workers to be paid less than junior ELM workers in anticipation of receiving higher wages as senior ILM workers. Hence, while workers in the ELM may be paid the value of their marginal product, junior ILM workers are paid less than their ELM counterparts, and senior ILM workers are paid more than their ELM counterparts. Additionally, it is commonly known in labor economics that an individual undergoing human capital training often receives a below-market wage during the training period followed by an above-market wage after the completion of training. These variations between wages and marginal productivity are not instances of "market failure" nor do they serve as counterexamples to the neoclassical model of wages and productivity. Rather, the present discounted value of expected productivity of a worker is equated to the present discounted value of the worker's wages for her entire working life within the firm. The internal labor market's wage structure can in fact be an efficient method for retaining workers who would otherwise hold up the firm by threatening turnover. The pay scale in an internal labor market can be skewed to encourage longer tenure within the firm. Thus, the existence of an ILM can be properly understood from a neoclassical, efficiency standpoint rather than an example of market failure or insulation from competitive market forces.

New institutional economists like Williamson expand upon the relationship between firm-specific capital, turnover, and internal labor markets. Williamson broadens the idea of firm-specific capital to include what he calls “task idiosyncrasies” or aspects of employment within a firm that are unique to the structure and input relationships within the firm. He identifies four categories of task idiosyncrasies which he labels as: 1) equipment idiosyncrasies, 2) process idiosyncrasies, 3) informal team accommodations, and 4) communication idiosyncrasies (Williamson 1975, 62). Williamson explains:

Also, whereas much of the internal labor market literature emphasizes noneconomic considerations, I interpret evolving institutional practices with respect to idiosyncratic production tasks principally in efficiency terms. (Williamson 1975, 57)

Hence, each firm has unique capital equipment, production processes, team production relationships, and even communication peculiarities that encourage the development of an ILM. In accord with neoclassical economists, Williamson explains these organizational structures in terms of efficiency and cost minimization. High turnover of employees prevents synergistic production effects associated with these group task idiosyncrasies. Furthermore, idiosyncratic interactions can reduce transaction costs over time. It is important to recognize that these idiosyncrasies do not imply insulation from external labor market forces, however. Rosen reminds us that while these idiosyncrasies imply transaction costs savings, there is always a “degree of substitution and competition from outside alternatives” however limited they may be at times (Rosen 1988, 56). Indeed, while task idiosyncrasies may encourage the development of internal labor markets, the ILM itself cannot shield the firm or its workers from the general supply and demand for labor in the marketplace, as we explain further below.

Williamson and other new institutional economists extend ILM analysis beyond human capital issues and task idiosyncrasies by highlighting the transaction cost efficiencies of internal labor markets in general. In addition to human capital (or “match-specific investments”), Wachter and Wright list three more factors that promote the development of an internal labor market: 1) risk aversion, 2) asymmetric information, and 3) transaction costs associated with writing and enforcing contracts (Wachter and Wright 242).¹¹ Each of these factors is pertinent to all firms, including bureaucratic “firms” like the Air Force.

Turning first to risk aversion, it is evident that both employers and employees face risks in their contractual relationship. Employers do not want to finance investment in human capital training for their workers, only to have these trained employees threaten to depart the firm if they are not offered an exorbitant wage. Similarly, an employee does not want to build up firm-specific capital (at the expense of foregone general human capital) only to be fired later. Workers are often considered to be more risk averse than employers (Wachter and Wright 1990, 246). In response to this risk aversion, an ILM can be structured in such a way as to provide the appropriate incentives to minimize turnover on the one hand, and increase job security for the employees on the other hand. An ILM attempts to do this by establishing known rules and procedures for advancement and known wage profiles. Once again, one consequence of this is that an individual may not be paid the value of his marginal product at any particular point in his work life (just as we have seen with respect to human capital training). As Wachter and Wright explain:

¹¹ See also pages 246, 248, and 251.

Efficient risk sharing thus requires that compensation be smoothed. Smoothing means that mp will vary by more than w , and at any point in time mp need not equal w . Hence, the risk-sharing model, like the match-specific investment model, predicts divergence between mp and w ...Both factors [risk aversion and match-specific investments] are needed to account for the empirical regularities. (Wachter and Wright 1990, 247)

In sum, risk aversion is another factor that enables us to account for the structure of internal labor markets. Predetermined wage structures, promotion rules, and ports of entry can mitigate the risks faced by both employer and employee.

Next, consider asymmetric information. Asymmetric information is relevant both to the existence of the firm and the structure of an internal labor market. Alchian and Demsetz (1972) highlight its relevance to the firm in terms of shirking and monitoring. An individual worker knows better than his employer how much effort he is contributing to team production. In response to this asymmetric information, firms emerge to monitor tasks. Wachter and Wright cite another example, viz., “firms having an advantage in determining the state of the product market and technology.” (Wachter and Wright 1990, 248). These economists explain that an efficient contract is one that “not only assign[s] the information gathering to the low-cost party, but also provide[s] a mechanism which prevents the information from being used strategically.” (ibid). An internal labor market does this very thing. Its structure can reduce the threat of asymmetric information (especially for the employee) by having a predetermined wage structure and career ladders, which are not immediately a function of the state of technology and the product market. Essentially, asymmetric information is an extension of risk aversion; a predetermined ILM structure can reduce opportunistic behavior that would otherwise occur due to asymmetric information.

Finally, the internal labor market can help improve efficiency by lowering the costs associated with writing and enforcing contracts. In external labor markets, short-term and anonymous interactions can result in strategic behavior. In contrast, economists generally agree that repeated interactions reduce strategic behavior because of anticipated future responses of the parties involved. Internal labor markets, by their very nature, create continuous interaction between the employer and employees. In fact, Williamson cites “small-numbers exchange relations” as “the leading reason why an internal labor market supplants spot contracting” (Williamson 1975, 60). Wachter and Wright elaborate on this idea:

Repeated transactions are less subject to opportunism than are short-run relationships. An opportunity for gain that results in a breakdown of the relationship is not likely to be pursued if there is much surplus to be lost or significant fixed costs to be incurred in terminating or restarting the relationship. Long-term relationships sometimes can reduce opportunities to misrepresent the outcomes of stochastic events due to the application of the law of large numbers; it is simply not acceptable to report that a certain advantageous outcome has occurred too often. (Wachter and Wright 1990, 251-252)

Internal labor markets design wage and promotion rules to encourage such long-run relationships between employers and employees. The next section shows how by using the Air Force as a specific example.

1.5 The Air Force as an Internal Labor Market

The military in general and the officer corps in particular is a near perfect example of an internal labor market. Numerous economists have pointed this out

including Becker (1962), Williamson (1975), Wachter and Wright (1990), Rosen (1992), and Asch (1993). Rosen (1992) in particular explains the implications of the military's ILM structure on wage and retention policies. The remainder of this chapter reviews the attributes of the Air Force that make it an ILM, and demonstrates why they are relevant to the problem of low pilot retention rates. Specifically, while the Air Force internal labor market cannot shield its employees from external labor market forces, it does provide an important means of responding to high turnover rates as they fluctuate with variances in human capital and job characteristics.

The structure of the Air Force is ultimately designed for the purpose of being an effective fighting force. Using the theory of the firm described above as a baseline of comparison, it is evident that the Air Force contains characteristics of an ILM that resolve some of the difficulties of match specific human capital investments, opportunistic behavior, contract contingencies, etc. Specifically, there are four organizational characteristics of the Air Force that are commonplace in internal labor markets. These four characteristics are: 1) ports of entry, 2) internal promotions with specific career paths, 3) wages attached to jobs, and 4) a rigid wage structure. In addition, the Air Force's "production process" has three unique aspects that make its use of an internal labor market more effective than spot-market exchanges on the external labor market. These three aspects are 1) a high degree of firm-specific human capital, 2) information impactedness, and 3) interpersonal interdependence (Long and Bedeian 1998, 183).¹²

¹² I use these categories in my analysis below. Long and Bedeian identify a fourth factor, "union representation," in their analysis (Long and Bedeian 1998, 183).

Where these three aspects exist, the Air Force makes use of an ILM structure. Where these three aspects are less prominent, spot-market contracting is more readily used.

Turning now to the four characteristics that make the Air Force an internal labor market, it is clear that there are ports of entry into the Air Force. Through these ports of entry, significant (and sometimes heterogeneous) investments in human capital are made. Air Force pilots must (ordinarily) first receive a commission through one of three sources: 1) the Air Force Academy, 2) the Reserve Officers Training Corps, or 3) Officer Training School. Following commissioning, medically qualified and accepted lieutenants enter Undergraduate Pilot Training (UPT).¹³ Similarly, other career fields also require entrance through a commissioning source and a specialized training program for its officers (e.g., missile officers, acquisition officers, etc.) So the first point is clear: the Air Force has ports of entry—one of the chief characteristics of an internal labor market.

Second, the Air Force promotes its own personnel from lower positions to fill higher positions and typically has specific career paths (or guidelines) for officers to follow. A lieutenant fresh out of pilot training may fill an entry-level position in a fighter wing. Lieutenants are promoted to captain and fill flight commander positions within the wing. Captains are promoted to major and fill important staff jobs at the Pentagon. This internal progression, promotion, and selection continue all the way up the chain of command. With respect to career paths, the Air Force publishes a *Career Path Guide* for all officer specialties. Assignment progression includes primary job proficiency at an Air Force base, staff assignments (e.g., the Pentagon), professional military training, career

¹³ The process of going to UPT is elaborated in Chapter 2.

broadening assignments, and major command experience. What makes such career progression important for our analysis is that officers are selected for senior positions from a pool of junior officers within the firm. In contrast, a private firm's chief executive officer may have no prior experience with that particular company. The Air Force's internal promotion and advancement is characteristic of internal labor markets, and makes retention all the more important to ensure the selection of top leaders from the best pool of candidates.

Third, wages are attached to jobs in the Air Force. A cursory examination of an Air Force pay chart reveals that officer wages (basic pay) are attached to the rank of the individual and the years of service the individual has (DFAS, n.d.). There are substantial pay raises with promotions in rank (e.g., in 2002 a captain with over ten years of service receives approximately \$623 more per month upon promotion to major). Pay raises accompanying experience tend to be more modest (e.g., a captain receives a \$162 per month raise once he completes his tenth year of service). Occasionally, officers receive higher pay (at junior officer ranks) if they have prior enlistment experience. Special pay is given for certain duties, such as hazardous duty pay (\$175 more per month for a captain in a hazardous duty assignment). Such special pays constitute compensating wage differentials (which are discussed in more detail in Chapter 3). Although other bonus pays are given for special categories, such as pilots and medical personnel (physicians, dentists, etc.), the salary structure of the Air Force is primarily one that is attached to a person's rank and tenure, and this is another characteristic of an ILM.

Finally, wages are rigid—and more rigid than those of internal labor markets in profit-maximizing firms. This is clear from the discussion above. Air Force wages are established by legislation. Dramatic adjustments to the pay scale (i.e., beyond annual cost of living adjustments) require considerable time and congressional negotiation. Hence, the Air Force basic salary structure cannot adapt quickly to changes in labor market forces. While all ILMs have some degree of wage rigidity, highly rigid wages are not beneficial to the cost-minimizing firm; firms need to remain flexible in the wages they offer or they may be unable to hire or retain the necessary personnel. Significant variations in Air Force retention rates are a manifestation of the consequences of inflexibility.

Two primary tools have been used by the Air Force to adapt to variations in pilot retention rates. The first was already mentioned: Aviator Continuation Pay (the pilot bonus) is authorized for pilots meeting certain qualifications. The second way is unique to the Air Force: unlike private firms, it can legally bind a person to fulfill his or her labor contract. The Active Duty Service Commitment (ADSC) for pilots graduating from UPT has changed three times since 1988 (Fullerton 2000, 16).¹⁴ The ADSC was as low as six years (prior to June 1988—and at one point was as low as five years) and was progressively raised to its current ten years (since October 1999). Of course, these ADSC changes are not without their own costs: an increased ADSC may distort the quantity and quality of new recruits through commissioning sources such as the Air Force Academy. Ultimately, if the Air Force does not offer competitive wages, it will have personnel

¹⁴ See also the Air Force News Service: http://www.af.mil/news/Aug1998/n19980828_981303.html

problems, as its pilot turnover difficulties evidence. Indeed, no internal labor market is able to completely insulate itself from the forces of the external labor market. Clearly then, these four attributes (ports of entry, internal promotions with specific career paths, wages attached to jobs, and rigid wage structure) indicate that the Air Force is an internal labor market.

1.6 The Internal Labor Market Structure: Necessary but Insufficient

Although the ILM structure is insufficient to maintain stable retention rates, there are several reasons why it is still necessary. As Long and Bedeian (1998) explain, these reasons include: 1) a high degree of firm-specific human capital, 2) information impactedness, and 3) interpersonal interdependence. As will be explained below, these characteristics are all present in the Air Force. However, an internal labor market must be accompanied by a properly skewed compensation system with sufficient pay distinctions, and the availability of bonuses, in order to maintain the organization's productivity and retention goals. Without such a discriminatory pay scale and an additional flexible component such as bonuses, perverse turnover rates often result.

Consider the first factor which often necessitates an ILM: a high degree of firm-specific capital. It is important to first recognize that, like other military services, the Air Force invests a tremendous amount of resources into specific human capital training for its personnel. Some types of training are more specific than others (e.g., primary flight training vs. training in a specific weapon system) and senior positions require long term experience within the firm. Each of these Air Force jobs is unique and requires many

years of both formal and on the job training in Air Force-specific capital. While it is true that all firms require some training in firm-specific capital, the Air Force is particularly unique since it is the only “firm” that provides the service of “defense of the skies.” Because the Air Force’s “product” (national defense) requires a great degree of firm-specific capital, an internal labor market is the most efficient organizational mechanism to provide the product.

National defense is also characterized by the other two marks identified by Long and Bedeian: information impactedness and interpersonal interdependence. Air campaign tactics, internal procedures and regulations, and access to classified information are all examples of very dense information that accumulates and develops with experience within the firm. Additionally, interpersonal interdependence is illustrated by the intense training that occurs within flying units. For example, consider a fighter squadron. There is a high degree of interpersonal interdependence between a fighter pilot and his wingman. Indeed, these two factors are evident characteristics of many Air Force combat career paths. This is another reason why the Air Force finds it advantageous to structure itself, and particularly its flying units, as an internal labor market.

Consider the procurement field as a contrast to the pilot career field. The procurement field makes more frequent use of spot-market contracting. Why the difference between procurement officers and fighter pilots? Clearly, procurement tasks (e.g., construction of a new building on base) do not contain the degree of information impactedness, interpersonal interdependence, or Air Force-specific capital that is found in

flying units. Hence, those career paths where these three characteristics are less prominent (such as procurement or engineering) make greater use of spot-market exchanges, as our analysis of internal labor markets suggests.

Though it is clear that the Air Force is structured as an internal labor market for efficiency reasons, it is also true that this ILM cannot shield Air Force personnel from supply and demand forces of the external labor market. A few examples will demonstrate that this is so. First, consider the turnover of Air Force personnel. Pilot turnover is of particular concern because of all the specific human capital training that the Air Force invests in its pilots (preliminary training, advanced training, weapon system training, etc.). Air Force pilots frequently exit to begin new careers in the airline industry. The wage differential between airline pilots and Air Force pilots explains this labor migration. The ILM does not prevent the turnover. So how does the Air Force respond? As previously noted, it has responded with both bureaucratic and free-market tools chief among which are: (1) making changes to the ADSC incurred by pilots who complete pilot training and (2) offering higher wages in response to changing retention rates through the use of pilot bonuses.

The Air Force's ILM cannot prevent turnover. But turnover is only one example of how the ILM is subject to the forces of the external labor market. The other side of the equation is the entry side. If the Air Force does not offer a competitive wage, it will be unable to meet its recruiting goals. Either it will have to lower the qualifications for entry, raise wages and benefits (non-wage amenities), or expect shortages in recruiting targets. Hence, whether it is on the entry side or the turnover side, the internal labor

market used by the Air Force cannot insulate its personnel from the forces of the external labor market as a whole. Indeed, extending the service commitment has its side effects on the entry side (i.e., fewer cadets applying for pilot training). However rigid or cumbersome its structure may be, the Air Force must adapt its wage structure to competitive economic forces. It cannot use forceful, bureaucratic tools and expect no perverse economic consequences to result. Internal labor markets may be an efficient method of organization, but they are by no means insulated from the laws of supply and demand.

Rosen has emphasized the importance of maintaining compensation flexibility and introducing more distinctions into military pay scales. While military members are offered a variety of non-monetary incentives as inducements to remain in the service, these are not as effective as flexible monetary compensation because not all individuals value non-wage amenities and benefits the same way (Rosen 1992, 231). Indeed, a “one size fits all” compensation policy is often inefficient for retention purposes. Rosen comments:

Those specialties, such as aircraft pilots, offering training opportunities that have lucrative payoffs in future civilian jobs find recruitment easy and retention difficult...Insufficient wage adjustments subsequent to training constrain the ability of the military to compete for the skilled labor that they themselves have created, and corresponding retention rates are smaller than average in those specialties. (Rosen 1992, 231)

While there are several compensation methods that can be used to compete for the Air Force’s skilled labor, the method of choice in the case of pilots for the past dozen years has been through the use of pilot bonuses. But changes in compensation do not have to be limited to “one size fits all” bonuses either. As will be elaborated in Chapter 3,

coupling bonuses with an increasingly skewed pay scale, and making bonuses a function of retention rates for particular specialties, could create more stable retention rates.

While the internal labor market structure of the Air Force is appropriate for the Air Force's unique size and mission, introducing greater flexibility and across-the-board pay distinctions are necessary to adapt to changing market conditions.

Conclusion

It is clear that firms arise as an efficient mechanism to organize production. The firm reduces costs associated with contracting and shirking. Firms occasionally employ an internal labor market to reduce opportunistic behavior associated with human capital investments, asymmetric information, risk aversion, and contracting costs. The ILM usually has ports of entry, internal promotions and specific career paths, wages attached to jobs, and a rigid wage structure. The Air Force is a particularly good example of an ILM. Its structure promotes cost-effective production of national defense, the accumulation of Air Force specific human capital, and the efficient use of information and joint production processes. For the purposes of analysis, the Air Force might even be considered the "ideal type" of internal labor market.

Ultimately, however, an internal labor market alone cannot insulate Air Force personnel from external labor market forces. Military pilot compensation must be competitive with civilian airline pilot compensation. Similarly, an Air Force major who is also an orthopedic surgeon must be given compensation beyond the standard base pay, or he will depart the Air Force for private practice. Indeed, the ILM is not an example of

market failure or an exception to the neoclassical theory of labor markets, but instead it is an institutional construct which must interact with the labor market as a whole. As such, the neoclassical and new institutionalist analysis of the internal labor market is a helpful addition to the theory of the firm and offers insight into the problem of Air Force pilot retention. Nevertheless, competitive wages are the key component in responding to high turnover. The determinants of turnover and the effectiveness of bonuses is the focus of the next chapter.

CHAPTER 2: HUMAN CAPITAL, SALARY BONUSES AND PILOT RETENTION

2.1 Introduction

The theory of labor turnover has been the subject of numerous theoretical and empirical studies. Labor turnover occurs as individuals either voluntarily seek to improve their lot by securing alternative employment or as firms seek to cut costs or increase profits by reducing the size of their workforce. Cost minimizing firms continually compete in the labor market to attract and retain productive workers. It is costly for firms to replace productive workers; search and retraining costs are incurred to acquire equally productive replacements. Because such turnover is costly, firms have an incentive to reduce it. This chapter examines how turnover is related to human capital and bonuses.

There have been numerous studies on the theory of employee turnover in general. Flanagan (1974, 1978) conducted some of the earlier work on the relationship between labor turnover and race. In the former paper, Flanagan examines the relationship between turnover and wage variations with race and variations in human capital, using the underlying hypothesis that a dual labor market exists where the primary market is characterized by high wages and opportunities for advancement and the secondary market is highly unstable with little opportunity for advancement. His empirical results are not supportive of the dual labor market hypothesis, and some evidence suggests that

job changes are in fact associated with higher earnings (Flanagan 1974, 523). In the latter study, Flanagan focuses on racial unemployment differences and examines how much can be attributed to racial turnover differences. He finds that while “there are no significant racial differences in quit or layoff probabilities”, the presence of wage discrimination among blacks tends to raise both the black quit rate and the probability that such quits will lead to lengthy job searches and unemployment periods of longer duration (Flanagan 1978, 202, 204).

Subsequent studies by Long (1982) and Long and Link (1983) further elaborate on labor turnover by examining turnover among government workers, as well as the relationship between market structure and turnover. In the former study, Long compares quit rates between public and private employees in similar jobs and uses quit rate variations as the basis for determining whether or not public employees are overpaid. His hypothesis is that “If public employees are receiving economic rents on their human capital, they will be less likely than private-sector workers to quit their present jobs” (Long 1982, 125). Using both National Longitudinal Survey (NLS) data and U.S. Census data, Long finds that the probability of quitting is significantly lower for public sector workers; this in turn suggests that public sector employees are overpaid relative to private sector employees. In the latter study, Long and Link examine the hypothesis that highly concentrated industries lead to higher wages and fringe benefits while lowering voluntary labor turnover (Long and Link 1983, 239). Using NLS data and a probit regression, they find that with respect to turnover, “[t]he coefficient of concentration is negative and

highly significant in both equations, indicating that the probability of quitting decreases as concentration rises" (Long and Link 1983, 248).

In a more recent study, Weiss (1984) examines the determinants of labor turnover from a sample of production workers in two plants of a U.S. manufacturing company. Using probit models to measure the quit probability of a worker within his first six months on the job, Weiss finds that younger workers are more likely to quit than older ones, less-educated workers are more likely to quit than well-educated ones, married workers are less likely to quit than unmarried ones, workers with more simple tasks are less likely to quit than those with complex ones, and those who were unemployed immediately prior to accepting their current job were more likely to quit than others (Weiss 1984, 372). In another study, Solnick (1988) examines the quit probabilities of professional employees in a manufacturing company. In contrast to Weiss, Solnick focuses on how the presence or absence of recent promotions for employees impacts their probability of quitting. Using a logit model, Solnick's empirical results were generally supportive of the hypothesis that the absence of a recent promotion increases the quit probability, though the results were mixed. The worker's field and managerial function was a relevant factor in determining whether or not the absence of a recent promotion had a significant impact on an individual's quit probability (Solnick 1988, 59-60). More recently, Campbell (1997) examines the determinants of worker quits (as well as dismissals and layoffs) within the first six months of their employment. Although his emphasis is on worker dismissals (in an attempt to test the shirking model of efficiency

wages), Campbell's research suggests that quit rates decrease for older workers and decrease with the presence of unions (Campbell 1997, 1072).

Other turnover studies have focused on military turnover specifically. Warner (1978) conducts a detailed examination of the determinants of attrition from military service using both individual and grouped linear probability models and a logistic model. Using a large cohort of Navy enlistees, Warner finds that individuals with less education and lower mental abilities (based on military vocational exams) were less likely to quit than those with more education and higher mental abilities (Warner 1978, 10, 12). Additionally, as one might expect, Warner found that the logit models were better at predicting attrition than the linear probability models were (ibid, 19-20). DeVany and Saving (1982) develop a life-cycle model of labor supply for military personnel. They first build an inventory model of labor supply and demand and then apply this model to the market for Air Force enlisted personnel. They conclude that "the quality [of the employee¹⁵] and length of wait [to enter the service] are important endogenous variables" in their inventory model (DeVany and Saving 1982, 464). Research by Ash, Udis, and McNown (1983) examines military enlistment supply with respect to relative civilian and military pay; they also calculate pay elasticities. Two recent studies focus on Air Force pilot turnover specifically. As mentioned in Chapter 1, Stone, et al (1998) summarize the empirical work done on Air Force pilot retention and then contribute with a logit model of their own. Most recently, Fullerton (2000) analyzes the determinants of Air Force pilot turnover. Using a data set on individual pilots from the Air Force Personnel Center,

¹⁵ Quality is measured by performance on the Armed Forces Qualification Test.

Fullerton runs several logistic regressions and analyzes the cost to the Air Force of replacing pilots due to low retention rates. This chapter of the dissertation expands upon his analysis by focusing on the impact of variances in human capital training and the effectiveness of salary bonuses on retention. As one would expect, there are numerous factors relevant to a pilot's decision to leave the Air Force. Understanding these determinants can lead to a more efficient compensation system.

Labor turnover is intimately connected to the theory of human capital. Gary Becker's 1962 paper is perhaps the most important foundational work on the economics of investments in human capital. In his research, Becker analyzes the myriad of forms human capital training can take, viz., on the job training, formal or institutional schooling, informal information gathering, and investments in such factors as improved health and morale. Becker is perhaps the first economist to formalize the relationship between human capital investments and worker earnings differentials, and analyzes the costs and benefits of such investments. He also incorporates a discussion of risk, information, and worker ability into his presentation. Becker's analysis forms the theoretical basis of this chapter of the dissertation.

Following Becker's path-breaking paper on the subject, economists have expanded and applied the theory of human capital to turnover and retention. For example, Parsons (1972) examines the effect of firm-specific human capital on firm turnover and wage policies. Specifically, he tests the hypothesis that quit rates are inversely related to worker investments in firm-specific human capital. He distinguishes worker investments in human capital from firm investments in human capital because the

latter is more pertinent to layoffs (as opposed to voluntary quits). Applying his models of quit rates and layoff rates to the manufacturing industry, he finds strong confirmation of the hypothesis that “average quit and layoff rates will be lower, *ceteris paribus*, in industries where worker- and firm-financed specific investments are heavy...” (Parsons 1972, 1140).¹⁶ Jovanovic (1979a, 1979b) integrates search theory and firm-specific human capital into a model of permanent job separations. His model “predicts that workers remain on jobs in which their productivity is revealed to be relatively high and that they select themselves out of jobs in which their productivity is revealed to be low” (Jovanovich 1979a, 974). In his follow-on study, Jovanovich develops a model of worker turnover where the investment decision in human capital and the search decision of the employee are endogenous (Jovanovich 1979b, 1248). In another application of Becker’s research, Hashimoto (1981) examines how the expenses of human capital training are distributed and shared by the firm and worker. This issue is important in the analysis of both quit and dismissal rates. Hashimoto’s research demonstrates that the way in which costs of investing in human capital training are distributed between the firm and the worker depends upon transactions costs. Specifically, it depends upon the transactions costs associated with estimating the future valuation of the worker’s productivity both within and outside the firm. In other words, Hashimoto demonstrates that Becker’s hypothesis is a “direct application of the Coase Theorem” (Hashimoto 1983, 475). Antel (1986) examines the trade-off workers face when choosing between investing their time in job search and investing their time in acquiring more firm-specific human capital with

¹⁶ Italics in the original.

their current employer. Black, Moffitt, and Warner (1990) examine the impact of relative government/civilian wages and other variables on labor turnover. An interesting and important contribution of their paper is their distinction between “*quit* propensities” and “[*h*]eterogeneity...in employment preferences” (Black, Moffitt, and Warner 1990, 245).¹⁷ Specifically, they seek to determine why quit rates decline with tenure: is this primarily a self-selection issue (i.e., heterogeneity of employment preferences becomes manifest with tenure as certain workers self-select into alternative employment while others self-select by remaining with the firm) or is it primarily because any random individual’s propensity to quit declines, *ceteris paribus*, with tenure? They find that self-selection (heterogeneity) is a much more important determinant than declining quit propensities *per se* (ibid, 261). More recently, McLaughlin’s (1991) study distinguishes between quits (voluntary turnover of workers) and layoffs (firm-initiated separations). He shows that this distinction does not imply that turnover is necessarily inefficient. That is, McLaughlin builds a model which demonstrates that “[t]he firm and worker dissolve their employment match if and only if their total value when separated exceeds the combined value of the match” (McLaughlin 1991, 3). Indeed, Becker’s theory of human capital has resulted in manifold applications.

The theoretical insights of Gary Becker can be applied to an analysis of Air Force pilot turnover. In his analysis, Becker (1962) distinguishes between specific and general training in human capital. In terms of worker productivity, specific human capital increases the worker’s marginal productivity to a greater degree in the firm which

¹⁷ Italics in original.

employs him than it does in other firms. In contrast, general human capital increases the marginal productivity of a worker equally across different firms. Human capital can be classified across a spectrum from the very general (e.g., high school education) to the highly specific (e.g., B-2 bomber mechanic). This distinction is not always sharp; human capital training falls along a continuum. To the extent that the distinction can be made, it has implications for the incentives individuals and firms have to invest in human capital. A firm has less incentive to bear the cost of general human capital training for its workers because a trainee could threaten to leave the firm and work elsewhere, leaving little if any benefits to be reaped by the firm which trained him. Firms making such investments are less likely to recoup the costs of the training they provide. As a result, the more general the training is, the greater the share of the training cost that is borne by the trainee.

In contrast, completely firm-specific human capital does not increase the incentive for an employee to work elsewhere. An individual with a substantial stock in firm-specific training is more likely to command a higher wage with her current employer than elsewhere, *ceteris paribus*. Because of this, firms are more inclined to bear the cost of specific human capital training than general human capital training. Since a worker cannot easily transfer firm-specific skills to another firm, she would have less of an incentive to invest in the training. Furthermore, because of this skill immobility, a firm recognizes that a trainee cannot use the specific training it receives to behave opportunistically. Becker explains that this non-transferability of training implies that “no rational employee would pay for training that did not benefit him” (Becker 1962,

18). For these reasons, the more specific the training is, the greater the share of the cost is borne by the firm.

The tendency of trainees to leave a firm is clearly related to the degree of specificity in the training they have received. To use an extreme illustration, suppose an individual spends a year receiving completely firm-specific training from his employer. Such training would increase his productivity with that firm (and thus his wage) but would not change his earnings potential outside the firm. As such, one would expect this worker's quit probability to be low. Becker summarizes the concept:

Employees with specific training have less incentive to quit, and firms have less incentive to fire them, than employees with no or general training, which implies that quit and layoff rates would be inversely related to the amount of specific training. Turnover would be least for employees with extremely specific training and most for those receiving such general training that productivity was raised less in firms providing the training than elsewhere. (ibid, 21)

Indeed, aggregate statistics of Air Force pilot turnover are generally consistent with this theory. Those pilots who fly aircraft which are particularly unique to the Air Force and whose advanced flying skills (i.e., specific weapons system training) are not as easily transferable to civilian aircraft have higher retention rates than those pilots who have skills which are much more easily transferred to civilian aircraft. This fact has clear implications for compensation policy. The first section of this chapter analyzes the impact of human capital on Air Force pilot retention.

Following human capital theory, the focus of this paper turns to the theory of bonuses as a tool to improve retention. Blakemore, Low, and Ormiston (1987) examined the effectiveness of bonuses to serve as an efficient retention tool. In contrast to Air

Force bonuses, Blakemore et al define bonus pay “as compensation that is indeterminate at the beginning of the contract period. It reflects, ex post, random events that affect the spot value of a worker such as unpredictable output prices, marginal products, or competing wage offers” (Blakemore, Low, and Ormiston 1987, S125). Air Force bonuses are not this random. Yet they are open to more flexibility than the base pay scales established by Congress. Blakemore et al explain that bonuses can be coupled with predetermined “base pay” to mitigate risks faced by both employees and firms (ibid, S127). In their empirical analysis, they find that “bonuses can become the dominant component of total compensation in the worker’s retention decision if the bonus is risk reducing and correlated with outside offers” (ibid, S134).

Little additional work has been done in the area of bonuses and retention (e.g., Hashimoto (1979)). The Air Force has used bonuses for retaining both enlisted personnel (re-enlistment bonuses) and for retaining pilots. Bonuses are also used in the military to respond to particular career fields and occupational specialties where there are acute manpower shortages. Bonuses provide a relatively flexible component to an otherwise highly rigid wage structure. As such, their use has the potential of being an efficient and effective tool to stabilize retention rates. Our regression models will be used to estimate the impact of bonuses on retention rates. This analysis will then be applied in the final chapter as part of a recommended wage and compensation system to stabilize retention rates. The models used to examine the bonus’s effectiveness are elaborated in more detail below.

2.2 Variations in Human Capital

Human capital takes many forms and is acquired by various means. For example, human capital is acquired through both education and on-the-job training. Formal training, such as pilot training or various apprenticeships, is another means by which human capital is acquired. The stock of human capital varies among pilots. Academic degrees are one example. Air Force pilots typically have a bachelor's degree (although some do not). Some have advanced academic degrees. Another example of human capital variation is the training required to become a commissioned officer. The three commissioning sources include the Air Force Academy, Reserve Officers Training Corps (ROTC), and Officers Training School (OTS). Finally, pilot training varies among pilots. Some are trained to fly centerline thrust aircraft such as the F-16 and other fighter aircraft. Others are trained to fly rotary wing aircraft (helicopters), bombers, or military-versions of common civilian aircraft (e.g., KC-10 air refueler versus the civilian DC-10). These pilots also have different levels of experience depending upon the number of flight hours they have acquired. Clearly then, Air Force pilots have different stocks and kinds of human capital.

The kind of human capital a pilot has is not entirely determined by the pilot's choices. Rather, the Air Force's training needs and requirements are the chief determinant of the kind of human capital acquired by a pilot; a pilot's desires are relevant, though secondary. For example, not everyone can receive a commission through the Air Force Academy. Additionally, not everyone can go to pilot training. The Air Force Academy is the commissioning source where it is most likely that a medically

qualified cadet will be approved for pilot training. The Reserve Officers Training Corps, Officer Training School, and special boards for active duty officers each employ different (and more competitive) selection processes for aspiring pilots (Carretta 2000, 952-953).¹⁸ Once a pilot graduates from UPT, his follow-on weapon system training is determined primarily by Air Force requirements and the results of competitive testing in UPT, and secondarily by the pilot's desires. To the degree that the pilot can determine the kind of training he receives, there may be some self-selection biases in empirical studies examining the relationship between human capital and retention. For example, the Air Force Academy is an institution specifically geared toward motivating and training cadets for lifelong service in the Air Force. Individuals accepted for training at this institution may therefore be more likely to be life-long Air Force officers than an individual who already possesses a bachelor's degree and decides to engage in short-term training through OTS. Similarly, a top graduate of UPT who chooses to fly a stealth fighter may be more likely to remain in the Air Force (where such aircraft are found exclusively) than a top graduate of UPT who chooses to fly a military version of a civilian airline aircraft.¹⁹ While much of the training acquired by a stealth fighter pilot is clearly more firm specific (i.e., Air Force unique) in nature than the training acquired by a C-9 pilot, and thus we would expect higher retention rates for the fighter pilot than the tanker pilot, there may also be some self-selection bias involved as well.

¹⁸ Carretta (2000) provides an excellent historical overview of the Air Force's pilot selection and training process. He notes that active duty and OTS selection ratios for pilot applicants tend to be much lower than those for the Academy and ROTC, especially during the drawdown period (953).

¹⁹ This assumes, of course, that both options were available to the graduate.

The cohort of pilots in our data set is collectively trained to fly well over a hundred different kinds of aircraft. With the exception of those who are trained to fly helicopters, these pilots all acquire a substantial amount of “general” flying training both in preliminary flying training (e.g., basic flying skills and instrument reading) and in the early phases of Undergraduate Pilot Training (UPT). The flying skills become more specific as the pilots are trained in specific weapon systems. As far as the transferability of these aircraft-specific skills are concerned, some aircraft flying skills are clearly more transferable to the civilian airline industry than others. A sample of these aircraft is given below in Table 2.1, with corresponding airline aircraft noted where applicable:

Table 2.1: Sample Aircraft

Aircraft Category	Sample Aircraft	Civilian Airline or Freighter Relative (Pettypiece, n.d.) ²⁰
Fighter/Attack	F-16C, F-15C, F-117A, F-111A, A-10, OV-10B, Tornado, Harrier	N/A
Bomber	B-52G/H, F/B-111, B-1B, B-2	N/A
Trainer	T-1, T-33, T-37, T-38, T-43	N/A
Tanker	KC-135A KC-10A C-9B C-18A C-22B C-32 C-137 E-3C E-4 E-8	Boeing 707 McDonnell Douglas DC-10-30 McDonnell Douglas DC-9 Boeing 707 Boeing 727 Boeing 757-200 Boeing 707-320C Boeing 707 Boeing 747 Boeing 707
Strategic Airlift	C-141B, C-17, C-5A	N/A
Tactical Airlift	C-130	N/A
Helicopter	UH-53, HH-60	N/A

²⁰ Source: http://www.csd.uwo.ca/~pettypi/elevon/gustin_military/db/

An inspection of retention data according to aircraft type reveals that the pilots of some aircraft have consistently lower retention rates than pilots of other aircraft. Two key retention statistics are calculated by the Air Force. The first is known as the Cumulative Continuation Rate (CCR). According to the Air Force Personnel Center (AFPC), the 6-11 year CCR measures the percentage of those Air Force pilots entering their 6th year of military service who will complete their 11th year of service assuming current retention rates continue.²¹ Thus, a CCR of 70 indicates that 70 percent of pilots entering their 6th year of service will complete their 11th year, if current rates continue. The second measure is known as the Total Active Rated Service (TARS). TARS measures the expected number of man-years the Air Force can expect to employ the average pilot upon the completion of pilot training. Tables 2.2 and 2.3 below list the CCR and TARS data from 1985 to 1999 according to aircraft category.

A previous study by the author (Barrows 1993) using two common aggregate measures of retention, Cumulative Continuation Rate (CCR) and Total Active Rated Service (TARS), demonstrated the general relevance of human capital on retention. The regression results from these aggregate data were generally consistent with economic theory: the greater the specificity of human capital training (as reflected in aircraft type), the higher the retention rates. The purpose of this chapter is to demonstrate the relevance of many forms of human capital and bonuses on pilot retention.

²¹ The Air Force also gathers CCR data for the 6-14 year group.

Table 2.2: Cumulative Continuation Rates from 1985 – 1999²²

Year	Fighter	Bomber	Tanker	Strategic Airlift	Tactical Airlift	Helicopter
1985	68.2	71.9	55.5	41.4	53.2	80.6
1986	63.3	51.2	50.4	40.9	51.9	81.6
1987	55.1	58.5	36.3	31.5	46.4	69.4
1988	49.2	50.5	36.9	24.7	41.8	69.3
1989	42.5	45.9	22.0	25.9	29.2	70.5
1990	43.0	52.1	31.0	21.2	36.2	68.1
1991	45.7	44.5	25.9	18.7	34.3	70.1
1992	38.7	51.7	27.6	21.0	37.4	84.4
1993	66.7	71.9	51.5	52.0	65.9	85.9
1994	83.4	85.3	78.4	77.4	81.6	81.0
1995	88.8	94.6	81.1	86.8	92.3	89.0
1996	78.0	82.3	73.4	76.6	79.7	85.7
1997	77.1	81.1	67.3	66.6	73.5	85.1
1998	52.0	54.1	46.0	36.4	46.8	58.7
1999	51.1	56.8	34.9	32.7	32.7	64.8
AVG CCR	60.19	63.49	47.88	43.59	53.53	76.28

Table 2.3: Total Active Rated Service from 1985 – 1999²³

Year	Fighter	Bomber	Tanker	Strategic Airlift	Tactical Airlift	Helicopter
1985	14.24	14.35	11.93	13.51	13.78	13.82
1986	13.89	12.83	12.12	11.42	12.19	15.89
1987	12.87	13.28	10.61	9.78	11.60	13.97
1988	12.46	13.28	10.61	9.78	11.63	13.95
1989	11.26	11.81	9.07	9.34	10.46	14.68
1990	9.99	10.56	9.94	7.62	11.05	15.06
1991	9.99	10.45	7.94	6.82	10.39	13.96
1992	8.25	10.42	8.66	6.37	8.88	13.05
1993	11.22	12.51	9.90	10.04	12.17	14.71
1994	13.92	14.16	13.04	12.00	12.97	13.28
1995	15.20	16.32	13.83	14.69	14.68	14.68
1996	13.96	13.19	12.34	13.48	14.54	16.48
1997	13.84	13.27	12.49	12.52	12.37	14.63
1998	11.50	10.44	11.33	11.16	11.55	13.46
1999	11.92	13.40	10.59	10.82	10.43	15.61
Avg TARS	12.30	12.68	10.96	10.62	11.91	14.48

²² Source: Air Force Personnel Center (AFPC/DPAOY).²³ Source: Air Force Personnel Center (AFPC/DPAOY).

2.3 Data

The data for this study were gathered from several sources. The primary source was the Air Force Personnel Center (AFPC/DPAOY). The data set acquired from AFPC initially contained extensive career and demographic information on over 90,000 Air Force pilots and navigators. This portion of the data used in this paper is the same data set acquired by Fullerton (2000) for use in his study. Due to the restricted availability of data from other sources for this study,²⁴ this analysis only examined those pilots from 1985 – 1999 with 6 to 11 years of commissioned service who faced their first opportunity to separate from the Air Force.²⁵ This resulted in a data set with 14,552 observations. This data set contained some missing observations for various demographic characteristics. Once these observations were eliminated, the final usable data set consisted of 14,165 observations on pilots with 6 to 11 years of commissioned service.

The reduction of the data set from 14,552 observations from the period of study (1985 to 1999) to 14,165 observations should not have adverse consequences on the statistical analysis. Descriptive statistics on the 387 dropped observations were gathered and compared to the retained observations. The descriptive statistics of both the retained and dropped observations are listed in Appendix A.

For this analysis, not all the demographic information in the data set was needed. The data set contained demographic information over the entire career of each pilot (e.g., number of dependents or accumulated flight hours). The only relevant demographic and

²⁴ Specifically, civilian airline pilot salary statistics were not available prior to 1984.

²⁵ Thus, the years of tenure varies for the observed individuals. Some individuals have six years of commissioned service, others seven, etc., up to eleven years of commissioned service. This contrasts with Fullerton (2000) who examined pilots serving from 1988 – 1999 with 6 to 10 years of *military* service.

human capital information was that which corresponded to the first year of separation eligibility, i.e., when a pilot has the opportunity to remain in or exit the Air Force. This first time eligibility follows the general approach used by Fullerton (2000). This eligibility-year data was isolated and extracted for each individual pilot and included in the regression models. For example, a pilot with one year of commissioned service may have been unmarried at the time he graduated from pilot training. After four years of commissioned service, he may be married with one child. These demographic facts are not relevant to this study. What is relevant (and thus what is retained for the econometric analysis) is the demographic information (e.g., marital status, number of dependents, etc.) during the year the individual makes his first decision to exit or remain in the military. Thus, in the above example this pilot may be married with three children during his first opportunity to separate, which may occur during his ninth year of commissioned service.

Unfortunately, using the first identifiable separation opportunity (i.e., the first time a pilot's active duty service commitment expires) undoubtedly creates a self-selection bias. The reason for this is straightforward. Pilots incur an active duty service commitment (ADSC) upon completion of pilot training. However, pilots can voluntarily extend that service commitment by accepting an assignment which has an ADSC that exceeds the commitment incurred from UPT. For example, a pilot may be approaching the end of his UPT service obligation. Six months prior to its expiration, he may volunteer and be selected for additional Air Force-funded training, such as a master's degree at a civilian institution. This would extend his obligation beyond that incurred from pilot training. However, such an individual manifests a bias to remain in the

service. An alternative to measuring retention on the basis of the first expired service commitment is to measure retention on the basis of whether or not the individual pilot extends her initial ADSC shortly before its expiration. The difficulties presented here are even greater, however. Specifically, this method would imply that the individual had an opportunity to separate when in fact the individual was not truly eligible: her UPT obligation was still applicable. Furthermore, one cannot infer that an individual who does not extend his ADSC will therefore separate when the commitment expires. Thus, it is preferable to use the first expired ADSC as the point where the “stay or leave” decision is actually made.²⁶ In order to reduce some of the bias associated with our definition of “first opportunity to separate,” an additional variable is incorporated in the econometric analysis to indicate the number of days separating the expiration of the UPT service obligation from the actual eligible separation opportunity. This is discussed in detail below.

In addition to the demographic and human capital data obtained from the AFPC/DPAOY data set, other economically relevant data were collected. These data include: the unemployment rate, the number of annual civilian airline pilot hires per eligible Air Force pilot, a dummy variable for those years that the Air Force was in a drawdown phase (1992 – 1995), a proxy for the non-wage amenities given to Air Force pilots, the historical promotion rates in the Air Force, and military aircraft safety statistics. The unemployment data were gathered from the Bureau of Labor Statistics.²⁷ For each individual, the quarter of the year in which he became eligible to separate was

²⁶ Fullerton (2000, 17-18) elaborates on this.

²⁷ <http://www.bls.gov/>

identified, and the average unemployment rate for the year prior to that quarter of eligibility was matched with each pilot. The number of annual civilian pilot hires was obtained from Aviation Information Resources (AIR), Inc. Historical promotion rates were acquired from the Air Force Personnel Center.²⁸ The proxy for non-wage amenities was annual statistics of total support expenditures for Air Force personnel, divided by the Air Force pilot inventory. These statistics were acquired from the Air Force Services Center.²⁹ The expenditures include morale, welfare, and recreation expenditures, family support expenditures, and similar non-wage benefits. Air Force safety statistics for military aircraft were acquired from the Air Force Safety Center.³⁰ For those few aircraft where safety data were unavailable, average safety statistics for that particular aircraft category were used. Annual Air Force pilot inventory data were acquired from the US *Air Force Statistical Digest*³¹ and the *US Air Force Budget Book*.

Finally, the most important variable for our analysis of pilot retention is a constructed relative lifetime income variable. Using historical military pay tables and civilian airline pilot salary surveys provided by AIR, Inc., an individually tailored relative lifetime income was constructed for each pilot according to the following algorithm:

$$(2.1) \quad \text{Relative Lifetime Earnings: } Y_{Rt} = \frac{PDV_{AF}}{PDV_{CIV}}$$

Where PDV_{AF} = Lifetime AF Earnings Stream:

²⁸ AFPC/DPSAR, available on line: <http://www.afpc.randolph.af.mil/>

²⁹ Specifically, Bruce Allen, AFSVA/SVFAF, provided data.

³⁰ These data are also available on line: <http://www.safety.kirtland.af.mil>

³¹ The USAF Statistical Digest is available on the internet for Fiscal Years 1995 – 2000: <http://www.saffm.hq.af.mil/>

$$\begin{aligned}
 (2.2) \quad & \sum_{t,y=1}^{11-YOS} \frac{(\$CPT_{t,y})}{(1+r)^t} + \sum_{t,y=5}^{15-YOS} \frac{(\$MAJ_{t,y})}{(1+r)^t} + \sum_{t,y=9}^{20-YOS} \frac{(\$LTC_{t,y})}{(1+r)^t} \\
 & + \sum_{t=1}^{ACIPyrs} \frac{(\$ACIP)}{(1+r)^t} + \sum_{t=1}^{BONUSyrs} \frac{(\$BONUS)}{(1+r)^t} + \sum_{t=20}^{60-AGE} \frac{(\$CIV_t)}{(1+r)^t} \\
 & + \sum_{t=75-AGE}^{75} \frac{(\$MRET_{t,y})}{(1+r)^t} + \sum_{t=60}^{75} \frac{(\$CRET_{t,y})}{(1+r)^t}
 \end{aligned}$$

Equation (2.2) describes the discounted earnings stream of a pilot who serves in the rank of captain (CPT) through the eleventh year of service, then serves as a major (MAJ) through the fifteenth year of service, and then serves as a lieutenant colonel (LTC) until he reaches retirement at the completion of twenty years of service. During this career, the pilot also receives a stream of Aviation Career Incentive Pay (ACIP) payments, and may be eligible for a stream of bonus (BONUS) payments. Upon retirement, the pilot receives a salary from the civilian airlines (CIV) as well as a military retirement pension during this time (MRET) and at age 60, he receives retirement pay from his civilian employment (CRET) until death occurs at age 75.

PDV_{CIV} is the Lifetime Civilian Pilot Earnings Stream:

$$(2.3) \quad \sum_{t,y=1}^{60-AGE} \frac{(\$SAL_{t,y})}{(1+r)^t} + \sum_{t=60}^{75} \frac{(\$CRET_{t,y})}{(1+r)^t}$$

where the data for $\sum_{t,y=1}^{60-AGE} \frac{(\$SAL_{t,y})}{(1+r)^t}$ is based upon typical career progression information

for pilots provided by AIR, Inc. Additional details explaining how this relative lifetime

income variable was created are found in Appendix B. An example of how this relative lifetime earnings variable is calculated for a sample pilot is shown in Appendix C.

2.4 Theoretical Models

Several models are used to estimate the impact of human capital and pilot bonuses on Air Force pilot retention. Logistic regressions were used for each model, and a linear probability model was also used to measure the marginal effects of the existence of the ACP bonus program (where the acceptance of a bonus is identified with a dummy variable). Additionally, each model was run several times using different discount rates in the construction of the relative lifetime income variable: 6 percent, 12 percent, and 18 percent.

The first model assumes the following general form:

Model 1:

$$(2.4) \quad R_i = \alpha + \beta YR_i + \delta K_i + \gamma X_i + \lambda U_i + \psi G_i + \phi Z_i + \mu_i \text{ where:}$$

R_i is the retention decision of individual i (0 = quit, 1 = stay)

YR_i is the relative present discounted value of military pilot earnings to civilian pilot earnings for person i

K_i is a vector of human capital characteristics

X_i is a vector of job characteristics and nonwage amenities

U_i is the average annual unemployment rate faced by individual i at the decision point (average of the previous year)

G_i is a vector of other pertinent economic variables

Z_i is a vector of demographic characteristics

μ_i is the residual

Specific variables, with the a priori predicted signs, are discussed below.

This particular model expands on the research of Fullerton (2000) in several ways. The first difference is the independent variables employed. My model consolidates some variables used by Fullerton and incorporates additional independent variables which correspond to job attributes. Each variable will be given an economic justification. With respect to variable consolidation, I broke down job assignment data used by Fullerton into two categories: those assignments which required the pilot to fly, and those assignments which had no flying duties. The following additional variables are employed as well. First, this regression incorporates an additional human capital variable that Fullerton chose to omit: education level. Dummy variables were used to identify individuals with no bachelor's degree, only a bachelor's degree, and an advanced degree (master's degree or above). Second, this regression includes a variable for the likelihood of advancement and promotion. *Ceteris paribus*, one would expect lower retention rates the less likely a pilot's chances are for future promotions. Historical promotion rates are used to test this proposition. Third, job safety—an attribute that is frequently examined in the compensating wage differential literature—is identified using historical military safety statistics. This variable identifies the number of major accident per thousand flying hours and applies it to each individual according to the aircraft he flies. This variable is lagged one year. To the extent that one military aircraft is less safe than another (without a corresponding compensating wage differential), one would expect lower retention rates for pilots of the unsafe aircraft. Fourth, I use a measure of non-wage benefits not employed in Fullerton's analysis. The total annual Air Force expenditures on morale, welfare, recreation, family support and other activities divided by the number of Air

Force pilots is used. This variable is also lagged one year. Fifth, my model uses an alternative measure of job stress. Fullerton approximated job stress by the number of Air Force deployments divided by the number of Air Force pilots. Due to the unavailability of data prior to 1988, I approximate job stress by the number of military personnel deployed overseas (not including the traditional overseas locations such as NATO countries, Japan, and Korea)³² and divide this number by the number of Air Force pilots. This measure should approximate the TEMPO of Air Force pilots by reflecting the support needed for contingency operations such as interventions in the Gulf War, Bosnia, and Haiti. This variable was also lagged a year from each pilot's eligibility date. Sixth, my model attempts to account for any self-selection bias by incorporating a variable (EXTEND) which captures the number of days a pilot extends his active duty service commitment beyond that incurred initially from pilot training. Presumably pilots who extend their service obligation manifest a bias to remain in the Air Force.

Most importantly, my model uses an alternative measure of compensation. Fullerton estimated the lifetime earnings difference between an Air Force pilot and a civilian pilot, coupled with an independent variable measuring the initial pay cut faced by a pilot who chooses to leave the Air Force and fly for the airlines. Instead, my model uses the relative lifetime income as described above, which has the advantage of incorporating discount rates (several discount rates are used), which are not accounted for in the lifetime pay difference estimated by Fullerton.

³² http://www.defenselink.mil/faq/pis/mil_strength.html These countries were excluded because they are associated with stable, longer-term assignments—many of them accompanied by the pilots' families. The number of deployed military personnel in "non-traditional" locations should more closely reflect the TEMPO faced by military pilots.

The incorporation of discount rates is very important: a recent study by Warner and Pleeter (2001) provides evidence that military members have very high discount rates. The structure of compensation in the civilian airline industry makes it necessary to incorporate discount rates in any relative measure of income. There are several reasons for this. First, an experienced military pilot typically takes a significant pay cut during the first two years flying for the civilian airlines. For example, consider an Air Force captain in 1995 with 8 years of commissioned service. If this pilot remains in the Air Force and accepts the bonus, his annual salary for the next two years is approximately \$67,336 annually (DFAS). In contrast, if this pilot separates to fly for the civilian airlines, he can expect to make (in 1995) approximately \$23,874 the first year and \$35,174 the second year (Career Pilot Survey 1995). His salary will not catch up for several years. Obviously the initial pay cut is significant.³³ The willingness of pilots to accept a severe pay cut initially and wait to “catch up” will be affected by their discount rate. Second, the salary structure in the civilian airline industry is notably skewed. Thus, the higher the discount rate, the less impact this skewed income in the “out years” has on an individual’s stay or leave decision. For example, the descriptive statistics in Appendix A show that as the discount rate increases, the relative income ratio rises: 0.734 for a 6 percent discount rate, 0.806 for a 12 percent discount rate, and 0.901 for an 18 percent discount rate. What this demonstrates is that pilots with high discount rates find the substantial pay raises occurring late in a civilian pilot’s career (e.g., those who are promoted to Captain of a Boeing 747) are less enticing than those pilots with low

³³ Some pilots may attempt to supplement their civilian airline salary by flying for the Air Force Reserves.

discount rates. The same holds true with the typical civilian airline retirement pay system—a system which is also significantly skewed with longevity. For these reasons, the relative lifetime income variable used in this study incorporates alternative discounts rates. The method used to calculate this data for each individual in the data set is elaborated in detail in Appendix B. Finally, I also use a model which breaks out the pilot bonus as a separate dummy variable, a separate dollar amount, and as a percentage of an individual's non-bonus military salary. This is further discussed below.

The second major difference from Fullerton's analysis is my use of a linear probability model (LPM) in addition to a logistic regression. Although linear probability models are plagued by heteroscedastic disturbances, there is an advantage to using the LPM in this case. Caudill explains that when a regression model includes an independent dummy variable (which represents group membership) where every member of the group makes the same choice, "the coefficient of the group dummy variable is not estimable in either logit models or probit models, but can be estimated in the LPM" (Caudill 1988, 426). This advantage of the LPM is particularly applicable to identifying the relative effectiveness of bonuses in retaining pilots. In the nature of the case, every pilot who accepts the bonus makes the choice to stay in the Air Force. However, not all pilots who stay in the Air Force accepted the bonus. As mentioned above, this is because the bonus program was not implemented until 1989 and my data go back to 1985. This provides another means of examining the marginal effectiveness of the bonus program since its implementation. Hence, the LPM will provide alternative information about the

effectiveness of the recent Air Force pilot bonuses. These linear probability model regressions constitute Model 2 as described in Equation 2.5 below:

Model 2:

$$(2.5) \quad R_i = \alpha + \beta YR_i + \theta B_i + \delta K_i + \gamma X_i + \lambda U_i + \psi G_i + \phi Z + \mu_i$$

where:

R_i is the retention decision of individual i (0 = quit, 1 = stay)
 YR_i is the relative present discounted value of military pilot earnings to civilian pilot earnings for person i (bonus not included)
 B_i is a dummy variable for acceptance of a bonus (yes = 1, no = 0)
 K_i is a vector of human capital characteristics
 X_i is a vector of job characteristics and nonwage amenities
 U_i is the average annual unemployment rate faced by individual i at the decision point (average of the previous year)
 G_i is a vector of other pertinent economic variables
 Z_i is a vector of demographic characteristics
 μ_i is the residual

Finally, to increase the robustness of the marginal effectiveness of bonuses, logistic regressions are run which: 1) break out the bonus (in discounted, inflation-adjusted dollars) as a variable separate from the relative lifetime income variable and 2) use the bonus measured as a percentage of non-bonus income. These logistic regressions constitute Models 3a and 3b which are described in Equations 2.6 and 2.7 below:

Model 3a:

$$(2.6) \quad R_i = \alpha + \beta YR_i + \theta B\$_i + \delta K_i + \gamma X_i + \lambda U_i + \psi G_i + \phi Z + \mu_i$$

where:

R_i is the retention decision of individual i (0 = quit, 1 = stay)
 YR_i is the relative present discounted value of military pilot earnings to civilian pilot earnings for person i (bonus not included)
 $B\$_i$ is the bonus as a real dollar amount (separated from YR)
 K_i is a vector of human capital characteristics

X_i is a vector of job characteristics and nonwage amenities
 U_i is the average annual unemployment rate faced by individual i at the decision point (average of the previous year)
 G_i is a vector of other pertinent economic variables
 Z_i is a vector of demographic characteristics
 μ_i is the residual

Model 3b:

$$(2.7) \quad R_i = \alpha + \beta YR_i + \theta BP_i + \delta K_i + \gamma X_i + \lambda U_i + \psi G_i + \phi Z_i + \mu_i$$

where:

R_i is the retention decision of individual i (0 = quit, 1 = stay)
 YR_i is the relative present discounted value of military pilot earnings to civilian pilot earnings for person i (bonus not included)
 BP_i is the bonus as a percentage of the discounted military income (without a bonus)
 K_i is a vector of human capital characteristics
 X_i is a vector of job characteristics and nonwage amenities
 U_i is the average annual unemployment rate faced by individual i at the decision point (average of the previous year)
 G_i is a vector of other pertinent economic variables
 Z_i is a vector of demographic characteristics
 μ_i is the residual

The second set of models in this chapter uses aggregate retention statistics maintained by the Air Force. These models will be used for comparison with the limited dependent variable models employed above. The models use the CCR and TARS data from 1985 - 1999. The second set of theoretical models is:

Model 4a:

$$(2.8) \quad CCR_{it} = \alpha_1 + \alpha_2 SPEC_i + \alpha_3 HIRPELIG_t + \alpha_4 SAFETY_t + \alpha_5 AMEN_t + \alpha_6 PROM_t + \alpha_7 OPT_t + \alpha_8 UNEMP_t + \alpha_9 YEAR + \varepsilon_i$$

Model 4b:

$$(2.9) \quad \text{TARS}_{it} = \beta_1 + \beta_2 \text{SPEC}_i + \beta_3 \text{HIRPELIG}_t + \beta_4 \text{SAFETY}_t + \beta_5 \text{AMEN}_t + \beta_6 \text{PROM}_t + \beta_7 \text{OPT}_t + \beta_8 \text{UNEMP}_t + \beta_9 \text{YEAR} + \mu_i$$

where subscript i = aircraft type and subscript t = year.

The results of all four models will be compared. Following an analysis of the results of the logistic and linear probability models, we will turn to our final chapter, which recommends an alternative compensation structure in light of hedonic pricing theory and the economics of tournaments.

2.5 Empirical Models

Specific Form

As mentioned above, the first three models employ data on individual retention decisions and include economic, demographic, human capital, and job characteristic information. The specific form of the first model is as follows:

$$(2.10) \quad R_i = \beta_0 + \beta_1 Y_{Ri} + \beta_2 \text{USAFA}_i + \beta_3 \text{OTS}_i + \beta_4 \text{ADVDEG}_i + \beta_5 \text{NOBACH}_i + \beta_6 \text{FLYJOB}_i + \beta_7 \text{FLYHRS}_i + \beta_8 \text{FTR}_i + \beta_9 \text{BMB}_i + \beta_{10} \text{TRN}_i + \beta_{11} \text{SAL}_i + \beta_{12} \text{TAL}_i + \beta_{13} \text{HELO}_i + \beta_{14} \text{MISC}_i + \beta_{15} \text{AMEN}_i + \beta_{16} \text{PROM}_i + \beta_{17} \text{SAFETY}_i + \beta_{18} \text{TEMPO}_i + \beta_{19} \text{TEMPO} * \text{MAR} + \beta_{20} \text{UNEMP}_i + \beta_{21} \text{HIRPELIG}_i + \beta_{22} \text{DRAW}_i + \beta_{23} \text{OVERSEAS} + \beta_{24} \text{EXTEND}_i + \beta_{25} \text{MEDICAL}_i + \beta_{26} \text{NFAM} + \beta_{27} \text{FEMALE}_i + \beta_{28} \text{MINB} + \beta_{29} \text{MINO} + \beta_{30} \text{MARSTAT} + \beta_{31} \text{MSPOUSE} + \epsilon_i$$

Where:

Ri	Retention decision (0 = quit; 1 = stay)
YR	Relative lifetime income
USAFA	Dummy variable for Air Force Academy graduate
OTS	Dummy variable for Officer Training School graduate
ADVDEG	Dummy variable for advanced academic degree
NOBACH	Dummy variable for no bachelor's degree
FLYJOB	Dummy variable for current assignment
FLYHRS	Thousands of flight hours (pilot's flying experience)
FTR	Dummy variable for fighter aircraft
BMB	Dummy variable for bomber aircraft
TRN	Dummy variable for trainer aircraft
SAL	Dummy variable for strategic airlift aircraft
TAL	Dummy variable for tactical airlift aircraft
HELO	Dummy variable for helicopter aircraft
MISC	Dummy variable for miscellaneous aircraft
AMEN[†]	Total Air Force expenditures on support activities per pilot
PROM[†]	Promotion rate ³⁴
SAFETY[†]	Military aircraft Class A accidents per 1,000,000 flying hours
TEMPO[†]	Operations Tempo (measure of stress)
TEMPO*MAR[†]	TEMPO interacting with marital status dummy variable
UNEMP[†]	Average unemployment rate (lagged one year)
HIRPELIG	Annual civilian pilot hires per eligible Air Force Pilot
DRAW	Dummy variable for Drawdown year (1992 – 1995)
OVERSEAS	Dummy variable for location of assignment
EXTEND	Days beyond UPT ADSC the first separation opportunity occurs
MEDICAL	Dummy variable for special medical situation
NFAM	Number of dependents
FEMALE	Gender (1 = Female)
MINB	Dummy variable for Black Minority
MINO	Dummy variable for "Other" Minority
MARSTAT	Dummy variable for marital status
MSPOUSE	Dummy variable for military spouse

³⁴ The promotion rate was adjusted to account for an individual pilot's proximity to a promotion board; this is elaborated below.

[†] These variables are lagged one year.

Relative Lifetime Income and Bonuses

The first set of models includes numerous demographic and economic variables. The dependent variable (R_i) in these models is a dummy variable: the choice of a pilot to remain in the Air Force or separate at his first opportunity (Quit = 0; Stay = 1). The bonus information is incorporated into the relative lifetime income (YR). As noted in Appendix B, three relative lifetime incomes are calculated, each with a different discount rate: 6 percent, 12 percent and 18 percent. Because this wage is the relative *military* income (military discounted lifetime income \div civilian discounted lifetime income), the a priori expectation is that the higher the relative military income, the more likely the individual will be retained. Hence, the sign is positive. Clearly raising the relative military income through the use of a pilot bonus should increase the probability that Air Force pilots will remain in the service.

Human Capital Variables

Numerous human capital variables are employed in the models, all but one of them being dummy variables. Dummy variables were employed for the commissioning source of each pilot. The commissioning source likely reflects how much Air Force-specific training an individual has and, as mentioned above, may also reflect some self-selection bias. The Air Force Academy provides the most extensive specific training: a four-year education complete with both academic and military training. The commissioning source that is likely to contain the least amount of specific training is Officers Training School (due to its short term nature). Hence, using ROTC as the

control variable, the a priori expectation is that USAF Academy graduates (USAF A) are more likely to remain in the service (positive sign) while OTS graduates (OTS) are less likely to stay (negative sign).

The level of academic education is also included as relevant human capital variables. Unfortunately, the level of education does not necessarily imply anything about the degree of specificity involved, save for the likelihood that advanced degrees are more narrow in scope. What can be said, however, is that individuals who do not have a bachelor's degree (less than 1 percent of the individuals in this study) are less likely to command a comparable wage in the civilian labor market (the military does not wage-discriminate on the basis of academic degrees, although to some extent it may impact the probability of promotion). Using bachelor's degree as the control, we used dummy variables to identify those individuals who had not earned a bachelor's degree (NOBACH) and to identify those individuals whose academic achievement included an advanced degree (ADVDEG), viz., for those with at least a master's degree. The a priori expectation is that individuals without a bachelor's degree are more likely to remain (positive sign) in the Air Force while those with an advanced degree are less likely to remain (negative sign) in the Air Force.

In addition to these variables, the kind of job the pilot had at his first opportunity to separate is also identified using a dummy variable. The job is identified as either one which requires flying as part of the individual's assigned duties (FLYJOB = 1) or one where no flying occurs (FLYJOB = 0). Presumably, an individual who desires to fly for the airlines will want to keep her flying skills current and increase her flying experience

and make every effort to be assigned where flying is required.³⁵ Hence, the sign on this variable is expected to be negative (if the person is actively flying, the less likely she is to be retained). The lone numerical variable, flight hours (FLTHRS), is expected to also be negative. That is, as a pilot gains flying experience, his likelihood of being hired by a civilian airline increases, which in turn implies a lower probability of retention, *ceteris paribus*.

Finally, dummy variables are used to identify the type of aircraft a pilot was qualified to fly at the decision point (fighters, bombers, trainers, strategic airlift, tactical airlift, and helicopters).³⁶ In addition to the six categories of aircraft listed in Table 2.1 above, one additional category (MISC) was added for those pilots whose aircraft qualification was not identifiable (0.741% of the aircraft fell into this unidentifiable category—105 out of 14,165 observations). The control variable—that dummy variable by which all other aircraft types are compared—was the aircraft type with the presumed greatest ease of training transferability: tanker aircraft. This category aircraft has the closest relatives in the civilian airline industry. As such, we would expect the lowest retention rates to occur in this category. The *a priori* expectation for the other aircraft categories is that flying one of these aircraft increases the probability of retention relative to that of tanker pilots. Becker specifically cites fighter pilots as an example of specific training where “productivity is raised in the military but not (much) elsewhere” (Becker 1962, 17). Hence, the expected sign on these variables (FTR, BMB, TRN, SAL, TAL,

³⁵ This is not always possible, however, since the Air Force’s requirements supercede the individual pilot’s desires when the two are not compatible.

³⁶ Pilots may be qualified in several aircraft. The most recent qualification is used for this variable.

HELO) is positive. Logically, one would expect the largest positive parameter to occur with helicopter pilots, whose skills constitute a highly specific form of human capital with respect to flying skills in general.³⁷

Amenities and Job Attribute Variables

Several variables were used in an effort to capture the impact of non-wage amenities or job attributes on retention rates. Many benefits are offered to civilian and military employees. These benefits are difficult to quantify: subjective preferences imply that individuals place different valuations on these amenities. Some require greater compensating differentials for workplace hazards than other do. This issue will be more fully addressed in Chapter 3 below. The four variables employed to capture non-wage amenities and job attributes are: 1) Air Force expenditures on amenities per pilot (AMEN), 2) the promotion rate to Major and Lieutenant Colonel (PROM), 3) the historical safety statistics of individual Air Force aircraft (SAFETY), and 4) a proxy for the deployment “stress level” or operations tempo (TEMPO). The first variable was calculated using the total annual Air Force expenditures on morale, welfare, recreation, family support and other activities divided by the number of Air Force pilots. This is used as a proxy for the amenities received by military pilots. The expected relationship between this variable and probability of retention is positive. The second variable was calculated using historical promotion rates for pilots. Historical promotion rates were

³⁷ Of course, there is a smaller industry of helicopter pilots, such as those who fly for television news crews, tourist companies, hospitals, etc.

obtained from the Air Force Personnel Center, AFPC/DPPPOO.³⁸ This variable integrates the years of commissioned service an individual has. For example, it is assumed that historical promotion rates are more important to a senior captain due to meet a major's board in the near future than a junior captain who has several years to wait for the promotion board. Hence, the historical promotion rates were assigned to each individual using the following formula: Promotion rate * $[\ln(\text{YOCS})]$, where YOCS is the years of commissioned service the pilot has at the decision point.³⁹ Taking the natural log of an individual's years of commissioned service results putting more weight on the recent promotion rates for those pilots with more tenure (i.e., those closer to the "major's promotion board" window). The expected relationship here is also positive (the more likely a pilot will be promoted, the more likely he is to remain in the service). The third variable was calculated using Air Force data on Class A mishaps.⁴⁰ Aircraft-specific safety statistics were acquired from the Air Force Safety Center.⁴¹ For those few aircraft for which such data were unavailable, average safety statistics for that aircraft's category were used. Clearly, if a pilot flies a type of military aircraft that is particularly accident-prone, the a priori expectation is that the probability of remaining in the Air Force will decrease relative to those who fly safer military aircraft. Thus, the sign on this variable should be negative. Finally, the fourth variable (TEMPO) and its interaction

³⁸ 1990s data were acquired from AFPC's web site: <http://www.afpc.randolph.af.mil> whereas 1980s data were provided by Autumn Foley, AFPC/DPPPOO.

³⁹ 11 years of commissioned service (YOCS) is historically the time period when an individual is promoted to major.

⁴⁰ Air Force Instruction 91-204 (Section 3.2.2.1) defines a Class A mishap as an accident which consists of at least one of the following: "Total mishap cost of \$1,000,000 or more...A fatality or permanent total disability...Destruction of an Air Force aircraft." (Air Force Instruction 91-204, 2001, 50).

⁴¹ <http://safety.kirtland.af.mil/AFSC/RDBMS/Flight/stats/usaf1097.html>

with a dummy variable for marital status ($TEMPO * MAR$) are measured by the number of military deployments overseas (not including NATO countries, Japan, and Korea) divided by the number of pilots. Presumably, contingency operations for missions in locations such as Bosnia, Haiti, Somalia, and other “atypical” locations require a concomitant increase in air support and thus a higher TEMPO. The former locations are more stable assignments and are less likely to have frequent manpower fluctuations due to contingency operations. A high operations tempo is an undesirable job characteristic, so as this variable increases, the probability of retention falls. Similarly, our a priori expectation is that such deployments are more stressful on married pilots than unmarried ones. Hence, it is anticipated that $TEMPO * MAR$ (where $MAR = 1$ if married, 0 otherwise) is also negative: a high operations tempo reduces the probability of retention even more for married pilots.

Other Economic Variables

The following economic variables were also included in the empirical analysis. First, each pilot was matched with an annual unemployment rate (UNEMP). This rate was calculated as the average rate for the year preceding each pilot’s eligibility to separate.⁴² The a priori expectation is that the unemployment rate is directly related to the probability of retention (positive). Second, data were gathered on the number of pilots hired annually by civilian airlines and the number of eligible Air Force pilots each

⁴² Unemployment data were gathered from <http://www.bls.gov/>

year.⁴³ These data were used to create a variable measuring the number of hires per eligible Air Force pilot (HIRPELIG). The a priori expectation is that as this ratio increases (more hires per eligible pilot) the smaller the likelihood of the pilot's retention (negative sign). Third, a dummy variable was used to identify the years in the early 1990s when the Air Force was substantially reducing the size of its force. The number of military personnel in the Air Force dropped from approximately 510,000 in 1991 to 400,000 in 1995 (Defense Technical Information Center, n.d).⁴⁴ Much of this force reduction coincided with highly effective separation incentives (Warner and Pleeter, 2001). Unfortunately, data are unavailable for those pilots who separated from the service during this drawdown phase and received one of the monetary incentives for doing so. Hence, this analysis employs a dummy variable to identify a drawdown year instead (DRAW). The drawdown incentives occurred from 1992 through fiscal year 1995. This unusual post-Cold War environment should be taken into account for our analysis. The relationship here between the drawdown period and the likelihood of a pilot remaining in the service is clearly a negative one. Finally, in addition to the drawdown years, a dummy variable was used to identify the geographic location of the job the pilot had when he became eligible to separate: overseas or not (OVERSEAS). As noted by Antel (1986), search costs are an important component in an individual's decision to switch jobs. As the costs of search rise, an individual is less likely to expend the time and effort to find alternative employment and will instead devote those resources to increasing firm-specific capital. Hence, a positive relationship to retention is expected

⁴³ The annual airline hiring statistics were provided by AIR, Inc.

⁴⁴ Source: Defense Technical Information Center, <http://web1.whs.osd.mil/mmids/military/ms9.pdf>

for this variable (the “search cost” to a pilot is higher when he is overseas than if he was in the United States during the eligibility year).

Finally, a variable called EXTEND, which is measured in days, is included in the regression to account for any potential self-selection bias of pilots who extend their service obligation beyond that incurred from UPT (as mentioned previously). As an example, if the pilot’s first separation opportunity is the same date as the expiration of his UPT service obligation, then EXTEND equals zero. In contrast, if a pilot accepts an assignment which extends his ADSC two years beyond that incurred from UPT, then EXTEND equals 730 (days). Presumably, individuals whose first opportunity to separate occurs after the expiration of their initial pilot training service obligation show a greater proclivity to remaining in the service. The relationship between EXTEND and R_i should thus be positive (the longer the pilot extends his ADSC beyond that incurred from UPT, the more likely it is he will be retained).

Demographic Variables

Finally, a few other demographic variables were used as independent variables. One variable indicates whether or not a pilot has a dependent with a special medical situation (MEDICAL). One of the most significant non-wage benefits of the military is the low cost medical care provided to active duty military members and their dependents. If a pilot has a dependent with a special medical situation, this individual can save substantial expense by taking advantage of the military health care system. Hence, the a priori expectation is that such individuals are more likely to be retained (positive sign).

The other demographic variables are the number of dependents (NFAM), and dummy variables for gender (FEMALE), minority status (African American minority (MINB), other minority (MINO)), marital status (MARSTAT), and whether or not the pilot is married to a military spouse (MSPOUSE). The expected signs on these variables are ambiguous or uncertain. Descriptive statistics for these variables, for both the retained and dropped observations, are listed below in Appendix A.

2.6 Ordinary Least Squares and Logistic Regression Results

Empirical Results

The coefficients and standard errors of the regressions from Model 1 are listed below in Tables 2.4 – 2.6. Each table reflects the results of the logistic regression using a different discount rate. Following a discussion of these results, the empirical results of Model 2 (the linear probability model) are listed in Tables 2.7 – 2.9. To check the robustness of the effect of bonuses on retention, additional logistic regressions were run for Model 3a, where the bonus is broken out in discounted dollar amounts (i.e., the bonus is removed from the relative income variable and stands alone), and Model 3b, where the bonus is also calculated as a percentage of the total non-bonus military salary received by the pilot. Models 3a and 3b are able to account for the heterogeneity of the bonuses offered (due to differing individual contracts or the effects of inflation over time), unlike the linear probability model used for Model 2. The results of these logistic regressions are listed in Tables 2.10 – 2.15. A discussion and analysis of the empirical results from Models 2 and 3 follow Tables 2.7 – 2.15.

Table 2.4: Logistic Regression (Model # 1)
Discount Rate: 6 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-14.150***	0.764	N/A
	YR	23.132***	0.739	Y
Human Capital	USAFA	0.395***	0.052	Y
	OTS	-0.526***	0.058	Y
	ADVDEG	0.346***	0.064	N
	NOBACH	3.031***	0.608	Y
	FLYJOB	-0.730***	0.099	Y
	FLTHRS	-0.630e ⁻³ ***	0.057e ⁻³	Y
	FTR	0.163*	0.085	Y
	BMB	0.590***	0.108	Y
	TRN	0.111	0.075	Y
	SAL	-0.059	0.082	N
	TAL	0.290***	0.085	Y
	HELO	2.053***	0.150	Y
	MISC	0.421*	0.252	N/A
Amenities	AMEN	-0.100e ⁻³ ***	0.020e ⁻³	N
	PROMOTE	-4.531***	0.256	N
	SAFETY	-0.002	0.002	Y
	TEMPO	-0.181***	0.022	Y
	TEMPO*MAR	-0.029	0.025	Y
Miscellaneous Economic	UNEMP	1.733***	0.049	Y
	HIRPELIG	-0.065***	0.006	Y
	DRAW	-2.275***	0.086	Y
	OVERSEAS	0.100	0.068	Y
	EXTEND	0.241e ⁻³ ***	0.084e ⁻³	Y
Demographic	MEDICAL	1.264***	0.180	Y
	NFAM	0.038	0.025	N/A
	FEMALE	-0.319**	0.140	N/A
	MINB	-0.097	0.167	N/A
	MINO	-0.119	0.174	N/A
	MARSTAT	-0.043	0.150	N/A
	MSPOUSE	0.202*	0.104	N/A

N = 14,165

86.8% Concordant

13.1% Discordant

0.1% Tied

* = Significant at the .10 level

** = Significant at the .05 level

*** = Significant at the .01 level

Likelihood Ratio = 6647

Table 2.5: Logistic Regression (Model # 1)
Discount Rate: 12 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-18.000***	0.809	N/A
	YR	25.929***	0.606	Y
Human Capital	USAFA	0.410***	0.055	Y
	OTS	-0.478***	0.062	Y
	ADVDEG	0.347***	0.066	N
	NOBACH	2.664***	0.619	Y
	FLYJOB	-0.862***	0.104	Y
	FLTHRS	-0.640e ⁻³ ***	0.060e ⁻³	Y
	FTR	0.067	0.091	Y
	BMB	0.524***	0.115	Y
	TRN	0.071	0.080	Y
	SAL	-0.060	0.087	N
	TAL	0.248***	0.091	Y
	HELO	2.127***	0.153	Y
	MISC	0.357	0.265	N/A
Amenities	AMEN	-0.180e ⁻³ ***	0.020e ⁻³	N
	PROMOTE	-3.569***	0.253	N
	SAFETY	-0.002	0.002	Y
	TEMPO	-0.251***	0.024	Y
	TEMPO*MAR	-0.031	0.027	Y
Miscellaneous Economic	UNEMP	1.825***	0.051	Y
	HIRPELIG	-0.098***	0.007	Y
	DRAW	-2.677***	0.093	Y
	OVERSEAS	0.058	0.073	Y
	EXTEND	0.143e ⁻³	0.087e ⁻³	Y
Demographic	MEDICAL	1.141***	0.196	Y
	NFAM	0.003	0.026	N/A
	FEMALE	-0.176	0.146	N/A
	MINB	-0.068	0.178	N/A
	MINO	-0.115	0.183	N/A
	MARSTAT	-0.171	0.160	N/A
	MSPOUSE	0.229**	0.111	N/A
N = 14,165		* = Significant at the .10 level		
89.7% Concordant		** = Significant at the .05 level		
10.2% Discordant		*** = Significant at the .01 level		
0.1% Tied		Likelihood Ratio = 7992		

Table 2.6: Logistic Regression (Model # 1)
Discount Rate: 18 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-19.018***	0.827	N/A
	YR	22.121***	0.485	Y
Human Capital	USAFA	0.418***	0.057	Y
	OTS	-0.381***	0.063	Y
	ADVDEG	0.355***	0.070	N
	NOBACH	2.485***	0.624	Y
	FLYJOB	-0.986***	0.107	Y
	FLTHRS	-0.630e ⁻³ ***	0.061e ⁻³	Y
	FTR	0.036	0.094	Y
	BMB	0.495***	0.120	Y
	TRN	0.051	0.083	Y
	SAL	-0.061	0.090	N
	TAL	0.233**	0.094	Y
	HELO	2.163***	0.157	Y
	MISC	0.317	0.272	N/A
Amenities	AMEN	-0.160e ⁻³ ***	0.021e ⁻³	N
	PROMOTE	-2.304***	0.254	N
	SAFETY	-0.001	0.002	Y
	TEMPO	-0.297***	0.025	Y
	TEMPO*MAR	-0.034	0.028	Y
Miscellaneous Economic	UNEMP	1.856***	0.053	Y
	HIRPELIG	-0.113***	0.007	Y
	DRAW	-2.872***	0.097	Y
	OVERSEAS	0.039	0.075	Y
	EXTEND	0.138e ⁻³	0.089e ⁻³	Y
Demographic	MEDICAL	1.087***	0.203	Y
	NFAM	-0.004	0.027	N/A
	FEMALE	-0.108	0.149	N/A
	MINB	-0.034	0.185	N/A
	MINO	-0.091	0.188	N/A
	MARSTAT	-0.220	0.166	N/A
	MSPOUSE	0.236**	0.114	N/A
N = 14,165		* = Significant at the .10 level		
90.8% Concordant		** = Significant at the .05 level		
9.1% Discordant		*** = Significant at the .01 level		
0.1% Tied		Likelihood Ratio = 8657		

Analysis of Model 1 Results

For the relative income and human capital variables, the results from the ordinary least squares regressions typically conformed to a priori expectations. Most noteworthy are the coefficients on the relative income and human capital independent variables.

First, for each discount rate used, the relative income coefficient was positive (as anticipated) and strongly significant. As the relative earnings for staying in the military rises, we would expect a higher probability of retention for each individual and the regression results are consistent with this hypothesis.

The signs on the majority of human capital independent variables conform to a priori expectations, and about half were highly statistically significant. With respect to commissioning source, the results were consistent with economic theory. Air Force Academy graduates (with four years of pre-commissioning military training) are more likely to remain in the military, while graduates of Officer Training School (with short-term military training) are more likely to separate. These commissioning sources reflect different stocks of military-specific human capital; Academy graduates have a larger stock of this capital upon commissioning than do OTS graduates. These coefficients were strongly statistically significant

Academic degrees had mixed results. First, as expected, those pilots without a bachelor's degree are much more likely to remain in the military. This is likely due to the reduced likelihood of earning a comparable wage in the civilian labor force without a bachelor's degree. On the other hand, those individuals with an advanced degree (e.g., Master's degree or higher) are also more likely to remain in the military, contrary to our

expectations. There are several logical explanations for this counter-intuitive result. First, a pilot with an advanced degree may also have a greater likelihood for advancement in the military (as opposed to those with only bachelor's degrees). Typically, civilian academic achievements are recorded on an individual's record and made available to promotion boards. Hence, those pilots with advanced degrees may have earned the degree with the primary intent of increasing their promotability within the Air Force and only secondarily to increase their marketability outside the Air Force. Second, the degree may reflect additional firm-specific training. A significant number of officers receive advanced degrees through the Air Force Institute of Technology (AFIT). AFIT offers degrees designed specifically for the benefit of the Air Force. Even AFIT degrees earned through civilian universities are often Air Force-related. Hence, the advanced degree could very likely be an indicator of additional Air Force-specific human capital, in which case the signs on this variable are wholly consistent with economic theory. Both education coefficients were strongly significant.

The variables reflecting the stock of flying skills also conformed to a priori expectations. The number of flight hours (experience) accumulated by the pilot, as well as whether or not his current duty assignment requires flying, were both negatively related to retention and were strongly statistically significant. These results appear to be consistent with anecdotal evidence suggesting that pilots who want to fly exclusively will attempt to accumulate flight hours and if possible transfer to the civilian airline industry where the risk of non-flying assignments is minimal (e.g., compared to filling non-flying billets in the Air Force).

The weakest results, however, are found among the aircraft-specific variables. Consistent with economic theory, all but one aircraft type (Strategic Airlift) possess the correct sign: as the human capital becomes more firm specific (i.e., Air Force unique), the probability of retention increases. However, only the Bomber, Tactical Airlift, and Helicopter coefficients were strongly statistically significant in every case. Fighters, trainers, and miscellaneous aircraft had coefficients which we cannot say were statistically different from zero. With respect to the Strategic Airlift anomaly, aggregate retention data also indicate that these pilots have the lowest retention rates on average, so the counter-intuitive results for these aircraft pilots are not too surprising. Additionally, these aircraft are similar in many respects to the tanker aircraft which is our control variable. Generally speaking then, the signs for the aircraft dummy variables are consistent with human capital theory, but statistically significant results only occurred for about half of the aircraft categories. Overall, nine out of thirteen of these human capital variables were strongly statistically significant.

The results of job attribute variables were mixed. The proxies used for two of the non-wage attributes of military employment (promotion rates and non-wage amenities) were typically the wrong sign and strongly statistically significant. The amenities variable is apparently a poor proxy for the non-wage attributes provided to each individual. Unfortunately, these aggregate data over 15 years cannot be altered and tailored to each individual. Some pilots may frequently make use of benefits such as the health and fitness centers, family support programs, and other morale and welfare activities provided at military bases. Others may rarely take advantage of these. Yet it is

not possible to distinguish among the individual pilots, which may be one explanation for the perverse sign. There are several possible explanations for the perverse sign on the promotion variable. First, promotion rates themselves might reflect turnover trends. For example, if the Air Force experiences high turnover rates among its junior officers, that would likely result in higher promotion rates for those officers who remain in the military. Hence, promotion rates could be a lagging indicator of prior year attrition rates. Second, the promotion rates are averages. Average promotion rates may not be a good indicator of an individual's likelihood of being promoted. Third, it may be difficult to capture how individuals with different years of service react to promotion rates. For example, an individual who is eligible to separate four years before his promotion board to major is not as likely to heavily weigh historic promotion rates in his decision-making compared to a pilot who is three months away from his promotion board. Although the empirical model attempted to account for this, the promotion rates were still contrary to expectations.

The other amenity variables, SAFETY and TEMPO (and TEMPO*MAR) always possessed signs consistent with economic theory and a priori expectations. However, only the TEMPO variable was consistently statistically significant. The p-values for SAFETY were not small enough to permit the conclusion that this coefficient is other than zero. The TEMPO and marital status interaction variable was also not statistically significant. Apparently the marginal safety differences across aircraft are not significant enough to impact retention rates measurably, and marital status does not significantly magnify the drawbacks of high job stress.

Next, the miscellaneous economic variables (unemployment rate, number of airline pilot hires per eligible pilot, military drawdown years and extension of service commitment) conformed to economic theory and were strongly significant. Consider the first two variables. As one would expect, rising unemployment increases the likelihood of retention. In contrast, as the number of civilian airline pilot hires per eligible pilot increases, the less likely it is that an Air Force pilot would remain in the military. Clearly these two economic variables serve as a good indicator of the relative demand for an Air Force pilot's labor services in the civilian labor force.

Now consider the second pair of economic variables. As expected, those pilots who first became eligible to separate during the drawdown years were less likely to remain in the military than those pilots who had their first opportunity to separate during other years. The EXTEND variable, which was used to capture any potential self-selection bias, possessed signs in each regression which conformed to a priori expectations: those individuals who extended their service obligation beyond that incurred from UPT were more likely to remain in the military when they first became eligible to separate. However, this variable was statistically significant only in the regression using a 6 percent discount rate.

Finally, the results of the demographic variables were typically not statistically significant. Two exceptions were MEDICAL and MSPOUSE, which were both statistically significant. Those individuals who have dependents with special medical needs are much more likely to remain in the Air Force, where doing so would likely result in a significant financial advantage by avoiding exorbitant health care costs which

might be incurred if the pilot separated from the service. Additionally, those individuals who have a military spouse are more likely to be retained. It is not clear why this is so. However, the military does make an effort to give joint assignments (i.e., the same location) to spouses who are both active duty military. It might be easier for such military couples to maintain two military careers than one military and one civilian career.

In order to check the marginal impact of offering bonuses to pilots, Model 2 excluded the bonus from the relative lifetime income variable and instead identified the acceptance of a bonus as a dummy variable for each individual. The results of this model are listed below in Tables 2.7 – 2.9. Although the marginal effects of the bonus are obtainable from the linear probability model, the bonuses themselves are heterogeneous; the maximum bonus increased from \$12,000 annually to \$22,000 annually in fiscal year 1998 and total bonus amounts vary depending upon the contract signed by the pilot. Additionally, inflation over the years makes the real value of these bonuses decline through time. To check the robustness of the results of Model 2, additional regressions were run based on Model 3 where the bonus is identified as a discounted dollar amount (Model 3a) and the bonus is measured as a percentage of the pilot's non-bonus military salary (Model 3b). The results of these logistic regressions are listed below in Tables 2.10 – 2.15. A discussion and analysis of the results of each of these Models follow the Tables.

Table 2.7: Linear Probability Model (Model # 2)
Discount Rate: 6 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-2.750***	0.091	N/A
	YR	0.316***	0.069	Y
	BONUS	0.726***	0.007	Y
Human Capital	USAFA	0.046***	0.006	Y
	OTS	-0.009	0.007	Y
	ADVDEG	0.041***	0.008	N
	NOBACH	0.095***	0.030	Y
	FLYJOB	-0.121***	0.011	Y
	FLTHRS	-0.066e ⁻³ ***	0.007e ⁻³	Y
	FTR	-0.002	0.010	N
	BMB	0.043***	0.013	Y
	TRN	0.001	0.009	Y
	SAL	-0.004	0.010	N
	TAL	0.017	0.010	Y
	HELO	0.221***	0.015	Y
	MISC	0.078**	0.032	N/A
Amenities	AMEN	0.037e ⁻³ ***	0.002e ⁻³	Y
	PROMOTE	-0.101***	0.030	N
	SAFETY	-0.259e ⁻³	0.184e ⁻³	Y
	TEMPO	-0.039***	0.003	Y
	TEMPO*MAR	-0.004	0.003	Y
Miscellaneous Economic	UNEMP	0.344***	0.006	Y
	HIRPELIG	-0.008***	0.790	Y
	DRAW	-0.532***	0.010	Y
	OVERSEAS	0.003	0.008	Y
	EXTEND	0.087e ⁻³ ***	0.009e ⁻³	Y
Demographic	MEDICAL	0.073***	0.018	Y
	NFAM	0.004	0.003	N/A
	FEMALE	-0.012	0.018	N/A
	MINB	0.029	0.020	N/A
	MINO	0.005	0.021	N/A
	MARSTAT	-0.002	0.019	N/A
	MSPOUSE	0.023*	0.013	N/A
N = 14,165		R ² = .604	Adjusted R ² = .603	

Table 2.8: Linear Probability Model (Model # 2)
Discount Rate: 12 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-2.673	0.092	N/A
	YR	-0.056	0.070	N
	BONUS	0.726***	0.007	Y
Human Capital	USAFA	0.046***	0.006	Y
	OTS	-0.002	0.007	Y
	ADVDEG	0.042***	0.008	N
	NOBACH	0.093***	0.031	Y
	FLYJOB	-0.123***	0.011	Y
	FLTHRS	-0.065e ⁻³ ***	0.007e ⁻³	Y
	FTR	-0.001	0.010	N
	BMB	0.043***	0.013	Y
	TRN	0.002	0.009	Y
	SAL	-0.003	0.010	N
	TAL	0.017	0.011	Y
	HELO	0.223***	0.010	Y
	MISC	0.080**	0.032	N/A
Amenities	AMEN	0.042e ⁻³ ***	0.002e ⁻³	Y
	PROMOTE	-0.048	0.048	N
	SAFETY	-0.283e ⁻³	0.184e ⁻³	Y
	TEMPO	-0.038***	0.003	Y
	TEMPO*MAR	-0.004	0.003	Y
Miscellaneous Economic	UNEMP	0.344***	0.006	Y
	HIRPELIG	-0.007***	0.008	Y
	DRAW	-0.525***	0.010	Y
	OVERSEAS	0.003	0.008	Y
	EXTEND	0.096e ⁻³ ***	0.010e ⁻³	Y
Demographic	MEDICAL	0.073***	0.018	Y
	NFAM	0.005*	0.003	N/A
	FEMALE	-0.013	0.018	N/A
	MINB	0.031	0.020	N/A
	MINO	0.006	0.021	N/A
	MARSTAT	0.245e ⁻³	0.019	N/A
	MSPOUSE	0.023*	0.013	N/A
N = 14,165		R ² = .604	Adjusted R ² = .603	

Table 2.9: Linear Probability Model (Model # 2)
Discount Rate: 18 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-2.581***	0.092	N/A
	YR	-0.344***	0.062	N
	BONUS	0.724***	0.007	Y
Human Capital	USAFA	0.056***	0.006	Y
	OTS	0.002	0.007	Y
	ADVDEG	0.042***	0.007	N
	NOBACH	0.091***	0.031	Y
	FLYJOB	-0.125***	0.011	Y
	FLTHRS	-0.064e ⁻³ ***	0.007e ⁻³	Y
	FTR	0.001	0.010	Y
	BMB	0.043***	0.013	Y
	TRN	0.002	0.009	Y
	SAL	-0.003	0.010	N
	TAL	0.017	0.011	Y
	HELO	0.223***	0.015	Y
	MISC	0.083***	0.032	N/A
Amenities	AMEN	0.048e ⁻³ ***	0.002e ⁻³	Y
	PROMOTE	-0.030	0.029	N
	SAFETY	-0.300e ⁻³	0.184e ⁻³	Y
	TEMPO	-0.037***	0.003	Y
	TEMPO*MAR	-0.004	0.003	Y
Miscellaneous Economic	UNEMP	0.349***	0.006	Y
	HIRPELIG	-0.006***	0.001	Y
	DRAW	-0.525***	0.010	Y
	OVERSEAS	0.003	0.008	Y
	EXTEND	0.107e ⁻³ ***	0.010e ⁻³	Y
Demographic	MEDICAL	0.074***	0.018	Y
	NFAM	0.007**	0.003	N/A
	FEMALE	-0.014	0.018	N/A
	MINB	0.033	0.020	N/A
	MINO	0.008	0.021	N/A
	MARSTAT	0.005	0.019	N/A
	MSPOUSE	0.022	0.013	N/A
N = 14,165		R ² = .604	Adjusted R ² = .603	

Table 2.10: Logistic Regression (Model # 3a)
Discount Rate: 6 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-16.502***	0.942	N/A
	YR	5.775***	0.675	Y
	\$BONUS	0.194e ⁻³ ***	0.068e ⁻⁷	Y
Human Capital	USAFA	0.333***	0.068	Y
	OTS	-0.100	0.076	Y
	ADVDEG	0.379***	0.081	N
	NOBACH	1.966***	0.676	Y
	FLYJOB	-1.300***	0.118	Y
	FLTHRS	-0.560e ⁻³ ***	0.070e ⁻³	Y
	FTR	0.684e ⁻³	0.112	N
	BMB	0.393***	0.146	Y
	TRN	0.025	0.100	Y
	SAL	-0.032	0.106	N
	TAL	0.196*	0.113	Y
	HELO	2.407***	0.172	Y
	MISC	0.532*	0.316	N/A
Amenities	AMEN	0.412e ⁻³ ***	0.028e ⁻³	Y
	PROMOTE	-1.440***	0.310	N
	SAFETY	-0.002	0.002	Y
	TEMPO	-0.265***	0.028	Y
	TEMPO*MAR	-0.053*	0.032	Y
Miscellaneous Economic	UNEMP	2.254***	0.061	Y
	HIRPELIG	-0.159***	0.012	Y
	DRAW	-3.420***	0.117	Y
	OVERSEAS	0.010	0.090	Y
	EXTEND	0.678e ⁻³ ***	0.100e ⁻³	Y
Demographic	MEDICAL	0.998***	0.248	Y
	NFAM	0.028	0.032	N/A
	FEMALE	-0.046	0.168	N/A
	MINB	0.300	0.211	N/A
	MINO	0.049	0.220	N/A
	MARSTAT	-0.004	0.193	N/A
	MSPOUSE	0.174	0.140	N/A

N = 14,165

93.8% Concordant

6.1% Discordant

0.1% Tied

* = Significant at the .10 level

** = Significant at the .05 level

*** = Significant at the .01 level

Likelihood Ratio = 11589

Table 2.11: Logistic Regression (Model # 3a)
Discount Rate: 12 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-16.194***	0.948	N/A
	YR	3.647***	0.710	Y
	\$BONUS	0.208e ⁻³ ***	0.733e ⁻⁷	Y
Human Capital	USAFA	0.329***	0.068	Y
	OTS	-0.036	0.076	Y
	ADVDEG	0.391***	0.081	N
	NOBACH	1.919***	0.671	Y
	FLYJOB	-0.001***	0.070e ⁻³	Y
	FLTHRS	-1.313***	0.118	Y
	FTR	0.005	0.112	Y
	BMB	0.390***	0.146	Y
	TRN	0.020	0.100	Y
	SAL	-0.040	0.101	N
	TAL	0.190*	0.113	Y
	HELO	2.413***	0.172	Y
	MISC	0.510	0.314	N/A
Amenities	AMEN	0.434e ⁻³ ***	0.028e ⁻³	Y
	PROMOTE	-0.966***	0.301	N
	SAFETY	-0.002	0.002	Y
	TEMPO	-0.267***	0.028	Y
	TEMPO*MAR	-0.051	0.032	Y
Miscellaneous Economic	UNEMP	2.220***	0.061	Y
	HIRPELIG	-0.159***	0.012	Y
	DRAW	-3.318***	0.115	Y
	OVERSEAS	0.013	0.090	Y
	EXTEND	0.711e ⁻³ ***	0.100e ⁻³	Y
Demographic	MEDICAL	1.003***	0.246	Y
	NFAM	0.038	0.032	N/A
	FEMALE	-0.041	0.167	N/A
	MINB	0.317	0.210	N/A
	MINO	0.050	0.219	N/A
	MARSTAT	-0.025	0.193	N/A
	MSPOUSE	0.180	0.140	N/A

N = 14,165

93.7% Concordant

6.2% Discordant

0.1% Tied

* = Significant at the .10 level

** = Significant at the .05 level

*** = Significant at the .01 level

Likelihood Ratio = 11550

Table 2.12: Logistic Regression (Model # 3a)
Discount Rate: 18 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-15.409***	0.954	N/A
	YR	0.831	0.674	Y
	\$BONUS	0.218e ⁻³ ***	0.768e ⁻⁷	Y
Human Capital	USAFA	0.326***	0.068	Y
	OTS	0.026	0.075	Y
	ADVDEG	0.396***	0.081	N
	NOBACH	1.873***	0.671	Y
	FLYJOB	-0.530e ⁻³ ***	0.070e ⁻³	Y
	FLTHRS	-1.341***	0.117	Y
	FTR	0.013	0.112	Y
	BMB	0.385***	0.146	Y
	TRN	0.020	0.100	Y
	SAL	-0.040	0.674	N
	TAL	0.190*	0.113	Y
	HELO	2.416***	0.171	Y
	MISC	0.515	0.315	N/A
Amenities	AMEN	0.469e ⁻³ ***	0.028e ⁻³	Y
	PROMOTE	-0.258***	0.028	Y
	SAFETY	-0.002	0.002	Y
	TEMPO	-0.051	0.032	Y
	TEMPO*MAR	-0.623**	0.295	N
Miscellaneous Economic	UNEMP	2.220***	0.061	Y
	HIRPELIG	-0.147***	0.012	Y
	DRAW	-3.255***	0.114	Y
	OVERSEAS	0.008	0.090	Y
	EXTEND	0.794e ⁻³ ***	0.100e ⁻³	Y
Demographic	MEDICAL	1.016***	0.244	Y
	NFAM	0.055*	0.032	N/A
	FEMALE	-0.046	0.167	N/A
	MINB	0.346*	0.210	N/A
	MINO	0.059	0.218	N/A
	MARSTAT	-0.015	0.193	N/A
	MSPOUSE	0.180	0.140	N/A

N = 14,165

93.6% Concordant

6.3% Discordant

0.1% Tied

* = Significant at the .10 level

** = Significant at the .05 level

*** = Significant at the .01 level

Likelihood Ratio = 11525

Table 2.13: Logistic Regression (Model # 3b)
Discount Rate: 6 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-16.558***	0.941	N/A
	YR	5.786***	0.675	Y
	%BONUS	142.7***	5.005	Y
Human Capital	USAFA	0.336***	0.068	Y
	OTS	-0.103	0.076	Y
	ADVDEG	0.379***	0.081	N
	NOBACH	1.969***	0.675	Y
	FLYJOB	-1.299***	0.118	Y
	FLTHRS	-0.560e ⁻³ ***	0.070e ⁻³	Y
	FTR	-0.001	0.112	Y
	BMB	0.389***	0.146	Y
	TRN	0.024	0.100	Y
	SAL	-0.034	0.106	N
	TAL	0.196*	0.113	Y
	HELO	2.406***	0.172	Y
	MISC	0.529*	0.316	N/A
Amenities	AMEN	0.411e ⁻³ ***	0.027e ⁻³	Y
	PROMOTE	-1.415***	0.309	N
	SAFETY	-0.002	0.002	Y
	TEMPO	-0.265***	0.028	Y
	TEMPO*MAR	-0.053	0.032	Y
Miscellaneous Economic	UNEMP	2.255***	0.061	Y
	HIRPELIG	-0.158***	0.011	Y
	DRAW	-3.413***	0.117	Y
	OVERSEAS	0.008	0.090	Y
	EXTEND	0.676e ⁻³ ***	0.099e ⁻³	Y
Demographic	MEDICAL	1.003***	0.247	Y
	NFAM	0.028	0.032	N/A
	FEMALE	-0.046	0.168	N/A
	MINB	0.300	0.211	N/A
	MINO	0.051	0.219	N/A
	MARSTAT	-0.002	0.193	N/A
	MSPOUSE	0.173	0.140	N/A

N = 14,165

93.8% Concordant

6.1% Discordant

0.1% Tied

* = Significant at the .10 level

** = Significant at the .05 level

*** = Significant at the .01 level

Likelihood Ratio = 11580

Table 2.14: Logistic Regression (Model # 3b)
Discount Rate: 12 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-16.311***	0.948	N/A
	YR	3.629***	0.709	Y
	%BONUS	83.311***	2.970	Y
Human Capital	USAFA	0.327***	0.068	Y
	OTS	-0.036	0.076	Y
	ADVDEG	0.391***	0.081	N
	NOBACH	1.922***	0.671	Y
	FLYJOB	-1.311***	0.118	Y
	FLTHRS	-0.540e ⁻³ ***	0.070e ⁻³	Y
	FTR	0.005	0.112	Y
	BMB	0.389***	0.146	Y
	TRN	0.021	0.100	Y
	SAL	-0.040	0.105	N
	TAL	0.191*	0.112	Y
	HELO	2.415***	0.172	Y
	MISC	0.504	0.314	N/A
Amenities	AMEN	0.439e ⁻³ ***	0.028e ⁻³	Y
	PROMOTE	-0.932***	0.301	N
	SAFETY	-0.002	0.002	Y
	TEMPO	-0.267***	0.028	Y
	TEMPO*MAR	-0.051	0.032	Y
Miscellaneous Economic	UNEMP	2.221***	0.061	Y
	HIRPELIG	-0.160***	0.012	Y
	DRAW	-3.312***	0.115	Y
	OVERSEAS	0.011	0.090	Y
	EXTEND	0.711e ⁻³ ***	0.100e ⁻³	Y
Demographic	MEDICAL	1.003***	0.245	Y
	NFAM	0.038	0.032	N/A
	FEMALE	-0.040	0.167	N/A
	MINB	0.317	0.210	N/A
	MINO	0.056	0.219	N/A
	MARSTAT	-0.024	0.193	N/A
	MSPOUSE	0.179	0.140	N/A

N = 14,165

93.7% Concordant

6.2% Discordant

0.1% Tied

* = Significant at the .10 level

** = Significant at the .05 level

*** = Significant at the .01 level

Likelihood Ratio = 11545

Table 2.15: Logistic Regression (Model # 3b)
Discount Rate: 18 Percent

Category	Variable	Coefficient	Standard Error	Sign as Expected?
Relative Income	INTERCEPT	-15.541***	0.954	N/A
	YR	0.807	0.673	Y
	%BONUS	59.202***	2.123	Y
Human Capital	USAFA	0.323***	0.068	Y
	OTS	0.028	0.075	Y
	ADVDEG	0.396***	0.080	N
	NOBACH	1.875***	0.671	Y
	FLYJOB	-1.339***	0.117	Y
	FLTHRS	-0.530e ⁻³ ***	0.070e ⁻³	Y
	FTR	0.014	0.112	Y
	BMB	0.384***	0.146	Y
	TRN	0.020	0.100	Y
	SAL	-0.039	0.105	N
	TAL	0.191*	0.112	Y
	HELO	2.418***	0.171	Y
	MISC	0.508	0.314	N/A
Amenities	AMEN	0.475e ⁻³ ***	0.028e ⁻³	Y
	PROMOTE	-0.590**	0.294	N
	SAFETY	-0.002	0.002	Y
	TEMPO	-0.258***	0.028	Y
	TEMPO*MAR	-0.051	0.032	Y
Miscellaneous Economic	UNEMP	2.221***	0.061	Y
	HIRPELIG	-0.148***	0.012	Y
	DRAW	-3.250***	0.114	Y
	OVERSEAS	0.007	0.090	Y
	EXTEND	0.795e ⁻³ ***	0.100e ⁻³	Y
Demographic	MEDICAL	1.014***	0.244	Y
	NFAM	0.056*	0.032	N/A
	FEMALE	-0.044	0.167	N/A
	MINB	0.345*	0.210	N/A
	MINO	0.063	0.218	N/A
	MARSTAT	-0.014	0.193	N/A
	MSPOUSE	0.179	0.140	N/A

N = 14,165

93.6% Concordant

6.3% Discordant

0.1% Tied

* = Significant at the .10 level

** = Significant at the .05 level

*** = Significant at the .01 level

Likelihood Ratio = 11525

Analysis of the Results of Models 2 and 3

In Model 2, the bonus was broken out as a dummy variable rather than included in the relative lifetime income and was run using a linear probability model. This has an advantage of indicating the marginal effectiveness of the bonus; prior to 1989 no bonuses were offered to pilots. One problem with this approach, however, is that the bonuses themselves are not homogeneous; the dollar amount of the bonus changed over the period under study and has also been a function of the length of contract the individual agrees to. Nevertheless, the sign on the bonus dummy variable conformed to a priori expectations.

One interesting factor is that for the coefficient for the relative lifetime income without the bonus (YR) only the model with the 6 percent discount rate resulted in a sign that was both consistent with a priori expectations and was statistically significant. The 12 percent discount rate yielded a coefficient that was statistically insignificant, and the 18 percent discount rate actually yielded a sign which is inconsistent with economic theory. Because everyone who received the bonus is automatically retained, the other income factors become less important (and on one occasion, there is a perverse relationship between them). The linear probability model is of limited use here. More robust models (Model 3a and 3b) can better gauge the bonus's marginal effectiveness.

Another interesting result of breaking out the bonus as a dummy variable is the impact it has on the variables AMEN and EXTEND. Previous regressions usually resulted in a sign opposite to a priori expectations for AMEN, and often statistically insignificant results for EXTEND. However, in each of the linear probability models in this case, the sign on AMEN was positive (as the non-wage amenities per pilot rises, the

probability of retention increases) and strongly statistically significant for all three discount rates. Next, consider the EXTEND variable. In each regression this variable was both strongly significant and possessed the correct (positive) sign: the longer a pilot extends his ADSC, the more likely he is to remain in the service.

Now consider the results of Models 3a and 3b. For the logistic regressions with the bonus measured as a dollar amount (adjusted for inflation and discounted), the signs on this coefficient were also consistent with economic theory. As the bonus accepted by a pilot increases as a percentage of their non-bonus military salary, the probability of retention rises. Of course, anyone who accepts a bonus is automatically retained. However, this measure helps us to understand how the bonus affects retention on the margin, since not all individuals retained take a bonus (i.e., from 1985-1988 the bonus was not offered). For Model 3b, where the bonus is measured as a percentage of the individual pilot's non-bonus military income, the results are similar to those of Model 2.

It is again noteworthy to point out that the signs on the amenities proxy (AMEN) in Models 3a and 3b are now consistent with economic theory (as the amenities per pilot increase, the probability of retention rises) and are statistically significant for each discount rate. The same holds true for the EXTEND variable. Interestingly, the sign on the human capital variable for OTS is no longer statistically significant in this Model.

2.7 Models 4a and 4b Results: CCR and TARS Data

The results from the regressions from the CCR and TARS aggregate statistics are listed in Tables 2.16 – 2.17. Each table shows the results of ordinary least squares.

Table 2.16: Aggregate CCR OLS Regression

<i>Explanatory Variables</i>	<i>Coefficients</i>	<i>Standard Errors</i>	<i>Sign as Expected?</i>
<i>INTERCEPT</i>	255.635	1403.831	N/A
<i>YEAR</i>	-0.043	0.711	N/A
<i>FTR</i>	10.880*	4.869	Y
<i>BMB</i>	14.936**	3.668	Y
<i>SAL</i>	-4.414	3.251	N
<i>TAL</i>	5.474*	3.266	Y
<i>HELO</i>	26.969**	4.876	Y
<i>DRAW</i>	-8.764*	4.450	Y
<i>HIRPELIG</i>	1.630	0.243	N
<i>AMEN</i>	-0.003	0.002	N
<i>PROMOTE</i>	-144.678**	49.939	N
<i>TEMPO</i>	-0.294	0.967	Y
<i>UNEMP</i>	3.771	3.564	Y
<i>SAFETY</i>	0.047	0.119	N
N = 90 F-stat: 30.85 R ² = 0.841 ** Statistically significant at the 0.01 level * Statistically significant at the 0.05 level			

Table 2.17: Aggregate TARS OLS Regression

<i>Explanatory Variables</i>	<i>Coefficients</i>	<i>Standard Errors</i>	<i>Sign as Expected?</i>
<i>INTERCEPT</i>	598.34**	162.465	N/A
<i>YEAR</i>	-0.290**	0.082	N/A
<i>FTR</i>	1.253*	0.563	Y
<i>BMB</i>	1.683**	0.425	Y
<i>SAL</i>	-0.344	0.376	N
<i>TAL</i>	0.942*	0.378	Y
<i>HELO</i>	3.434**	0.564	Y
<i>DRAW</i>	-1.065*	0.515	Y
<i>HIRPELIG</i>	0.130**	0.028	N
<i>AMEN</i>	6.649e ⁻⁵	0.182e ⁻³	Y
<i>PROMOTE</i>	-13.767*	5.779	N
<i>TEMPO</i>	-0.0227	0.112	Y
<i>UNEMP</i>	-0.093	0.412	Y
<i>SAFETY</i>	0.003	0.014	N
N = 90 F-stat: 24.18 R ² = 0.805 ** Statistically significant at the 0.01 level * Statistically significant at the 0.05 level			

Analysis of Models 4a and 4b Results

The second set of models, which used aggregate retention data for this time period rather than individual data, yielded results which were roughly similar to those of the models using individual data. First, for both the CCR and TARS data, the regression results for fighter, bomber, tactical airlift, and helicopters were all consistent with the theory of human capital. Each of these coefficients was strongly statistically significant. Once again, the human capital exception was for strategic airlift pilots. Pilots of these aircraft had the lowest retention rates of all. It should be noted, however, that the coefficients on the strategic airlift variables for both the CCR and TARS regressions are not statistically significant. The drawdown year variable was statistically significant in both regressions, and the sign was negative each time as expected. The unemployment rate variable was correctly signed: as the unemployment rate rises, the retention and tenure rates increase. Surprisingly, however, in both regressions UNEMP was statistically insignificant. The variable measuring annual airline hires per eligible pilot (HIRPELIG) had signs in each regression which were contrary to a priori expectations.

The variables for non-wage amenities and job attributes had mixed results. The promotion variable (PROMOTE) and the safety variable (SAFETY) did not have signs consistent with economic theory. In both cases, the PROMOTE variables were statistically significant whereas the SAFETY variables were statistically insignificant. The signs on the AMEN variables were mixed as well, and the coefficients were not statistically significant. In contrast, the operations tempo (TEMPO) variable had signs

which were consistent with a priori expectations. Unfortunately, however, the TEMPO variables were not statistically significant.

Both models had approximately the same explanatory power: the CCR regression had an R^2 of .841 and the TARS regression had an R^2 of .805. For those variables with disappointing results for the signs (SAFETY, PROMOTE, HIRPELIG), the possible explanations for such results remain the same as for those models with individual data. Nevertheless, the primary focus of this chapter—the effect of human capital variances on retention—appears to yield results in these aggregate regressions which are consistent with the theory of human capital. The type of aircraft one flies does impact retention rates in a way usually consistent with human capital theory.

Summary

Overall the results of the regressions in this chapter show strong conformity with the expectations posited by the theory of human capital. Generally speaking, the more firm specific the training is, the higher the retention rates are. The one consistent exception to this was the sign on Strategic Airlift pilots. Both individual and aggregate data indicate that these pilots are more likely than any others to separate from the Air Force, *ceteris paribus*. The heavy, multi-engine aircraft require flying skills not unlike those required to fly a civilian airline or freighter, however. Hence, the degree of human capital specificity is not as strong as, say, that for fighter or helicopter pilots. Additionally, there may be other job attribute factors associated with flying these aircraft which may induce their pilots to separate.

The human capital associated with advanced degrees had signs consistently contrary to expectations. However, a very reasonable explanation is likely: the kind of advanced degree earned by pilots may itself be firm specific. The other measures of human capital, such as commissioning source and flying experience measured by flight hours, are all consistent (with one exception for OTS) with the theory of human capital.

It is clear that the offer of bonuses have had a substantial effect in inducing individuals on the margin to remain in the Air Force. Isolated from the relative lifetime income variable, the bonus offer is clearly the single strongest factor in the retention decision of Air Force pilots. It outweighs the unemployment rate, safety factors, job stress (TEMPO) and any other single factor. The bonus is effective. However, effectiveness does not necessarily imply economic efficiency. The bonus could presumably be tailored more specifically to the individual pilot, thereby improving the efficiency of the bonus as a retention tool. It is to this topic that we turn in Chapter 3, as we shift the focus to compensating differentials and a more efficient compensation system.

CHAPTER 3: COMPENSATING DIFFERENTIALS AND PILOT RETENTION

3.1 Introduction

In Chapter 1 it was shown that the Air Force's internal labor market structure could not shield its pilots from external labor market forces. Chapter 2 highlighted the impact that human capital variances and pilot bonuses have on pilot retention. This chapter examines more closely the economics of equalizing differences or compensating wage differentials. It shows how the theory of equalizing differences can be applied to pilot retention, and recommends changes to the Air Force's current compensation system in light of this theory. Specifically, this chapter is outlined as follows. First, the theory of compensating differentials is discussed and a review of the empirical work accomplished in this area is provided. This is coupled with a review of the hedonic price theory literature. Following this theoretical background and literature review, a proposed equalizing differences model based upon Solnick, Henderson, and Kroeschel (1991) is provided. This model is then used to estimate compensating differentials across major aircraft categories. It is also applied to compensation for variations in job stress (as measured by TEMPO) and job safety (as measured by SAFETY). Finally, the economics of tournament theory is reviewed and applied to the proposed changes in the Air Force compensation system.

3.2 Compensating Differentials and Hedonic Price Theory: Theoretical Background

For centuries, economists have recognized that workers receive additional monetary compensation for disagreeable job characteristics. This additional compensation is referred to in the literature as a “compensating wage differential” or sometimes as an “equalizing differential.” As explained in Chapter 1, the military has paid compensating differentials for years. Currently, the primary compensating differential for pilots is Aviation Career Incentive Pay (ACIP). The military has other compensating differentials. Soldiers and airmen can receive Hostile Fire pay, Chemical Munitions Exposure pay, Demolition Duty pay, and even Leprosy Duty pay (OSD 1996, xiii-xiv).⁴⁵ Indeed, compensating wage differentials are necessary to meet the unique demands for military personnel in different occupations. One of the more familiar introductions to the theory of labor compensation comes from none other than Adam Smith. In 1776, Smith notes several reasons why there is an inequality in wages. He states:

The five following are the principal circumstances which, so far as I have been able to observe, make up for a small pecuniary gain in some employments, and counter-balance a great one in others: first, the agreeableness or disagreeableness of the employments themselves; secondly, the easiness and cheapness, or the difficulty and expence of learning them; thirdly, the constancy or inconstancy of employment in them; fourthly, the small or great trust which must be reposed in those who exercise them; and fifthly, the probability or improbability of success in them. (Smith 1981, 116-117)

The theory of compensating differentials alluded to by Adam Smith is simply an extension of the theory of labor supply and demand. Economic theory posits that an

⁴⁵ Leprosy Duty pay was eliminated in 1984.

individual's decision to supply labor in the marketplace varies with the wage rate. The wage rate is essentially the price (opportunity cost) of not working. Stating it another way, how much leisure a person consumes (i.e., how much labor she avoids) is a function of the price of leisure (i.e., the wage rate). Like all other goods, the demand for leisure is downward sloping; that is, as the wage increases, the amount of leisure consumed declines. This implies that as the wage rate increases, a person supplies more labor to the market (*ceteris paribus*).⁴⁶ Individuals allocate their time between labor and leisure in a way that maximizes their well-being or utility. This utility consists of satisfaction derived from leisure activities as such, and satisfaction derived from consuming goods and services—which require income derived through supplying labor to the marketplace.

On the demand side, firms hire workers up until the revenue generated by the marginal worker equals the cost of employing that additional worker. In more technical language, firms hire labor until the marginal revenue product of labor equals its marginal factor cost. The cost of hiring an employee is not restricted to monetary compensation, of course. In principal, the employer could compensate the worker by providing him with goods and services directly rather than with money.⁴⁷ Firms often do this by providing employees with a host of benefits such as health insurance, stock options, fitness centers, and paid vacation time, to name just a few examples. Indeed, few employers restrict the form of compensation to mere monetary compensation. Firms must account for these non-monetary forms of compensation when calculating the

⁴⁶ Empirical studies indicate that an individual's upward sloping labor supply curve may eventually bend backwards. This is because the income effect resulting from a higher wage can result in the individual "purchasing" more leisure—i.e., he can afford to work less because his hourly wage is so high.

⁴⁷ Monetary compensation serves the same purpose in the labor market as it does in any other market: it is a medium of exchange.

marginal cost of employing an additional worker. Individuals place different monetary valuations on these non-monetary forms of compensation. The labor market matches employers and employees according to individual valuations of monetary compensation, non-monetary benefits, and job attributes (whether good or bad). Adverse working conditions influence an individual's decision to supply labor in the marketplace. It is costly for firms to remove or mitigate adverse working conditions. For example, textile workers might prefer working in an air-conditioned environment, but providing such an environment might be very expensive. The firm and the workers are thus faced with choices. The firm must decide whether or not to spend the money to improve the working environment (which might in turn increase worker productivity—a benefit which also must be accounted for) or to compensate workers for the hot and sticky working conditions by paying higher wages. Similarly, the workers must decide whether or not to accept a higher wage with poor working conditions, or forego that higher wage for the sake of an air-conditioned working environment. Because individuals' tastes and preferences vary, the labor market matches individual preferences with wages and working conditions. A graphical depiction of this is found in Figure 3.1 below. In this figure, Workers A and B and Firms X and Y face tradeoffs between a safe working environment and wages. Worker A's preferences are different from those of Worker B, viz.; Worker A manifests a relatively greater preference for higher wages compared to Worker B. Similarly, Firm X manifests a greater preference for providing higher wages than improving the working environment. For Firm X, the marginal cost of making the workplace a more comfortable environment is more costly (relatively speaking) than it is

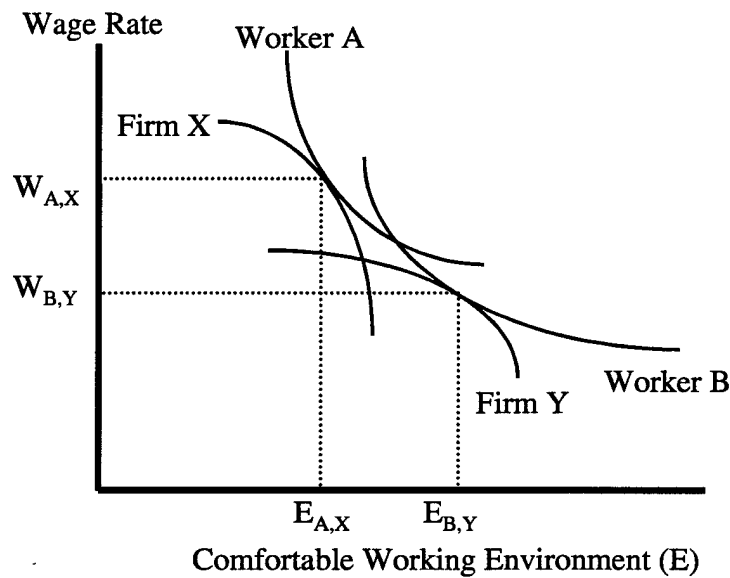


Figure 3.1: Labor Market Preference Matching

for Firm Y. A match occurs: Worker A accepts the offer of Firm X and enjoys higher wages than Worker B; Worker B accepts Firm Y's offer and enjoys a more comfortable working environment than that found at Firm X. Thus, for two similar jobs with the same monetary wage, if Job A has a less comfortable working environment than Job B, a person will choose Job A over Job B only if he is compensated for the discomfort (i.e., given a compensating wage differential). As job attributes worsen, the worker must be compensated with higher wages in order to supply the same amount of labor in that job. This additional compensation is what is referred to by the term compensating differential.

One of the best introductions and reviews of the theory of compensating differentials is that provided by Rosen (1986b). Rosen underscores the essential theoretical aspects of the theory of compensating differentials. He points out that models

of labor supply and demand differ in an essential way from the standard model of perfect competition found in consumer theory. In the latter, consumers and producers are price-takers, and prices fluctuate to clear the market. In the former, wages and non-wage amenities work together to achieve “a matching and sorting function of allocating or assigning specific workers to specific firms” (Rosen 1986b, 642). He continues:

The actual wage paid is therefore the sum of two conceptually distinct transactions, one for labor services and worker characteristics, and another for job attributes. The positive price the worker pays for preferred job activities is subtracted from the wage payment. The price paid by employers to induce workers to undertake onerous tasks takes the form of a wage premium, a negative price for the job, as it were. (643)

The crucial point is that the firm faces a tradeoff between the cost of offering a higher wage and the cost of providing better non-wage attributes or working conditions for employees. Likewise, workers face a tradeoff between the cost of foregoing a higher wage and the cost of demanding more non-wage amenities or improved working conditions. This is what is illustrated in Figure 3.1 above.

Because firms face different cost functions and workers have different preference functions, occupations arise with an array of wages and non-wage amenities and job attributes. Throughout his paper, Rosen provides examples where the theory of equalizing differences can be applied. Equalizing differences can reflect the value of workplace safety, comfort, the repetitive nature of tasks, geographic cost of living conditions, human capital requirements, employment uncertainty and instability, working hours, and income risk (661-668). Rosen also cites military compensating differentials as an example of where the theory applies (666-667). One important area of research

Rosen identifies is how non-pecuniary compensation applies to the theory of equalizing differences (669). Although compensating differentials can be measured in monetary terms, they can also be made manifest in non-pecuniary ways.

3.3. Compensating Wage Differentials and Hedonic Pricing Models: Literature Review

Most of the empirical efforts to find evidence of compensating wage differentials in the marketplace employ some aspect of hedonic pricing theory. While the outlines of hedonic pricing theory are found as early as Adelman and Griliches (1961), who developed a hedonic pricing model in response to difficulties associated with creating price indexes, the consumer theory upon which hedonic pricing models rest can be traced back to the work of Lancaster (1966). Lancaster asserts that consumers seek to maximize their utility not by consuming goods *per se*, but rather by consuming various *qualities* and *characteristics* of which goods are comprised. Furthermore, while the goods themselves have explicit prices, *implicit* prices can be attached to these characteristics. Thus, an individual's grocery-purchasing decisions reflect his desire to consume an array of characteristics from which he derives utility: vitamins and minerals for good health, certain flavors and spices for taste, microwave dinners to save time, etc.⁴⁸ Lancaster's new approach to consumer theory was in some respects anticipated by Adelman and Griliches' hedonic pricing models. They sketched out a method for adjusting price

⁴⁸ Lancaster (1966) summarizes his approach by stating: "1. The good, *per se*, does not give utility to the consumer; it possesses characteristics, and these characteristics give rise to utility. 2. In general, a good will possess more than one characteristic, and many characteristics will be shared by more than one good. 3. Goods in combination may possess characteristics different from those pertaining to the goods separately." (134).

indexes for quality improvements in automobiles (Adelman and Griliches 1961). Their study was a response to a common problem in calculating price indexes: since goods are not homogeneous over time (e.g., a Dell laptop computer in 1998 is not the same as a Dell laptop computer in 2002), how can price indexes account for quality improvements in these goods? In a manner similar to Lancaster's subsequent paper on consumer theory, Adelman and Griliches focus on certain characteristics of goods and attaches implicit prices to these characteristics.

Rosen (1974) provides a rigorous theoretical analysis of hedonic prices in markets with product differentiation. He explains that "Hedonic prices are defined as the implicit prices of attributes that are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them" (Rosen 1974, 34-5). Rather than focusing on a general class of goods, hedonic pricing models focus on the implicit prices of characteristics found in each good or service consumed. Rosen explains that any particular good in a class of commodities contains an array of objectively measurable attributes $z = (z_1, z_2, \dots, z_n)$, and that the market price of a good is a function of the implicit prices associated with each characteristic. Lucas (1975) summarizes this general class of hedonic price functions as follows:

$$P_i = P(Z_{i1}, \dots, Z_{ij}, u_i)$$

where P_i = observed price of commodity i ;

Z_{ij} = measurable quantity of some characteristic j for commodity i

u_i = a disturbance term (Lucas 1975, 157).

One common application of hedonic pricing theory is in real estate markets. The market price of a house is a function of the number of bedrooms it has, its total square feet, geographic location, age, and whether or not it has a swimming pool. In principle, hedonic prices can be applied to the labor market in terms of hedonic wages which reflect different occupational characteristics, as we have seen above.

Following Rosen's (1974) paper, research using hedonic pricing models expanded to many applications. Lucas (1975, 1977) evaluates alternative applications of hedonic price functions and expands this hedonic analysis by developing hedonic wage equations to estimate how wages vary according to various job characteristics. In his 1975 paper, Lucas provides an excellent overview of hedonic price functions, their relationship to Lancaster's consumer theory, and those areas where they either can or cannot be easily applied. For example, the use of hedonic pricing methods presupposes that the characteristics or qualities accounted for are objectively measurable rather than subjective or abstract (Lucas 1975, 168, 176). Lucas uses as an example the contrast between a car's weight versus its comfort. The former is clearly measurable on a cardinal scale whereas the latter can at best only be measured ordinally. Furthermore, the car's weight does not vary from consumer to consumer, whereas the perception of comfort is consumer-dependent. In his 1977 paper, Lucas uses both job characteristics and personal demographic data to develop hedonic wage estimates. He assumes that these demographic data can be used as proxies for individual tastes and preferences. That is, "tastes are at least partially conditioned by some vector of measured personal characteristics of the worker..." (Lucas 1977, 550) Some of his estimates are consistent

with Adam Smith's theory of compensating differentials. For example, his regression results indicate the existence of wage premiums for jobs with repetitive tasks and environments with extreme working conditions such as extreme heat or cold, noise, strong odors, etc., (554-555). Furthermore, his empirical analysis supports Smith's description of the relationship between human capital and wages: "that tasks associated with higher levels of specific vocational preparation...do pay considerably higher wages *ceteris paribus*..." (557).⁴⁹ Lucas' work provided a significant theoretical and empirical contribution to the estimation of compensating wage differentials through the application of hedonic price theory.

Using this general hedonic wage approach outlined by Lucas, economists have made numerous additional attempts to find empirical verification of Adam Smith's theory of compensating differentials. Most of the "successful" empirical work has been done in the past two decades. With the notable exception of Lucas' results, much of the research before 1980 was not particularly supportive of Smith's theory. An early literature review by Brown (1980) provides a good summary of the empirical and theoretical work done on compensating differentials up to that time. Most studies estimating compensating differentials regress individual wages or annual earnings (or the natural log of these variables) as a function of various job attributes. Brown's review of the empirical work underscores the surprising inconsistency of the empirical evidence with Smith's theory. In fact, he notes that at best only one compensating differential appears to be somewhat consistent with Adam Smith's theory: compensation for high probability of work

⁴⁹ Italics in the original.

fatalities (Brown 1980, 117). The other characteristics are frequently either the wrong sign or are statistically insignificant. According to Brown, one of the most common explanations for the inconsistent and occasionally contradictory empirical results “is the omission of important worker abilities, biasing the coefficients of the job characteristics” (118). Brown’s study examines whether or not this is a reasonable explanation for the disappointing empirical results. His analysis includes yearly dummy variables, human capital variables, unionization, and various demographic characteristics. The four job characteristics he includes are: 1) repetitive tasks, 2) stress, 3) physical strength requirements, and 4) extreme conditions (e.g., cold, heat, and various hazards). He also substitutes the probability of death for extreme conditions (124). Even using individual-specific intercepts and wage changes (rather than fixed wage levels) to control for an omitted variables bias (due to variable or unmeasured worker attributes), Brown’s results were still inconsistent with economic theory (116 ff). Among other explanations, Brown suggests that the subjectivity of preferences for various job attributes and the poor measurement of job characteristics are likely reasons for these disappointing results (132).

Although Brown’s literature review indicates that the theory of equalizing differences has surprisingly little empirical evidence to support it, research subsequent to 1980 has been somewhat more supportive. Kumar and Coates (1982) examined the relationship between compensating differentials and differences in human capital training, experience, job security, and earnings risk. Using data from Canadian male workers, Kumar and Coates’ results are consistent with human capital theory: that

schooling and experience are very important factors in explaining wage differences. Additionally, their results for non-pecuniary job attributes conform to economic theory: wages rise with higher earnings risk, and fall with higher employment stability (Kumar and Coates 1982, 453). They point out that while variations in the stock of individual human capital are one primary explanation for variations in wages, “the hedonic approach focuses on ‘quality’ variations in both worker and job attributes as an explanation for wage differences” (443).

In another empirical study, Atrostic (1982) builds a demand system where the individual’s wage is endogenous. To identify job characteristics, Atrostic includes the survey responses of individuals, measured on a scale of 1 to 9. His research is used to demonstrate that “job characteristics, as well as the money wage and prices, are important determinants of labor supply” (Atrostic 428). In another application, Woodbury (1983) develops a hedonic pricing model to estimate workers’ preferences for wage and non-wage amenities. He notes that non-wage amenities have become increasingly important as part of firms’ overall compensation package. His paper estimates the elasticity of substitution between the two and concludes that money wages and fringe benefits are easily substituted for one another. Specifically, he estimates that the elasticity of substitution between wages and fringe benefits ranges from 1.7 to 3.5 (Woodbury 1983, 179).

Duncan and Holmlund (1983) conducted one of the more important studies on job characteristics and compensating differentials. In their research, Duncan and Holmlund use panel data from survey reports of male Swedish workers to estimate compensating

differentials. Following Brown, they focus on *changes* in wages rather than wage levels. This method, along with the use of worker-reported characteristics, has as its objective the reduction of “the bias due to unobserved individual fixed effects” (Duncan and Holmlund 1983, 371). They use individual surveys of *changing* working conditions as independent variables in their analysis. In other words, Duncan and Holmlund are able to remove the influence of static individual characteristics which may be either unobserved or immeasurable by using changes in wages (since changes in these individual characteristics do not exist, because they are static). Using this method, they find that the signs on 75 percent of the independent variables are consistent with economic theory. In contrast, they find that using wage levels (as opposed to changes in wage levels) results in only 50 percent of the signs conforming to a priori expectations (374). This wage change approach thus reduces the biases associated with measurement error and omitted variables. Its approach is one of the more successful ones used to verify the theory of compensating wage differentials.

Eberts and Stone (1985) seek to surmount difficulties found in early empirical investigations by including employer attributes in their empirical models. They argue that firm-specific information such as the firm’s profitability and the presence of collective bargaining are important factors in estimating compensating differentials. They include such variables in their specification. They also use a differencing approach (in both the independent and dependent variables) to reduce bias (Eberts and Stone 1985, 277). Their data set comes from a single market: New York elementary and secondary school teachers. With one exception, the signs on their independent variables are

consistent with the theory of compensating differentials. They conclude that “the role of firm-specific information in tests of compensating differentials appears very important” (278). The results of their research were a dramatic improvement over the empirical results of previous studies.

Combining the insights of the previous three studies above, Hersch (1989) estimates a human capital earnings equation in difference form using worker-reported job attributes. She uses the change in the natural logarithm of annual earnings as her dependent variable. For job characteristics, she includes safety, measures for effort (fast, hard, or repetitive), weekly hours worked and regularity of hours, commuting time, and the availability of benefits. Her results are more consistent than Brown’s (1980), but not as consistent as those obtained by Duncan and Holmlund (1983) or Eberts and Stone (1985). Though both Brown and Hersch use changes in wages, Hersch asserts that her more consistent results are due to worker-reported job characteristics rather than Brown’s imputed characteristics (Hersch 1989, 48).

The results of several papers published in the 1990s are consistent with Smith’s theory of compensating differentials. Montgomery, Shaw, and Benedict (1992) apply hedonic price theory in the labor market, focusing instead on the substitutability between pensions and wages. They find that “the demand for pensions rises significantly with a worker’s age and assets and the supply rises with firm size and FICA tax burden” (Montgomery, Shaw, and Benedict 1992, 125). More recently, French and Dunlap (1998) estimated compensating differentials for job stress. This study is unique in its ability to combine research found in the medical and public health literature with

economic theory. Using employee survey data from six different industries, their results are consistent with the theory of compensating differentials: they find that jobs with higher stress pay higher wages (French and Dunlap 1974). Unfortunately, worker reports of job attributes are subjective, and may not correspond with the employer's perception of those same attributes. Because both the demand for labor and the supply of labor are relevant in the theory of compensating differentials, it is important to include the employer's assessment of non-wage job attributes as well. In another article published the same year, Elliott and Sandy (1998) provide such an assessment. They find

that worker's evaluations of the disamenities they face in their work are associated with their dissatisfaction over pay...some disamenities provide more scope for over reporting than do others. Further, some disamenities are clearly less important than others and may not show up as significant without a much larger sample....Unobserved differences in productivity are undoubtedly part of the problem—particularly for variables such as promotion prospects where employers have an incentive to tie these to ability. (Elliott and Sandy 1998, 131)

Thus, more recent analyses of compensating wage differentials have shown empirical results which are more consistent with economic theory. It is clear that empirical work in this area is most successful in verifying the theory when it accounts for: 1) fixed individual characteristics (i.e., by using a differences approach), 2) subjective individual preferences (i.e., by obtaining worker-reported job attributes), 3) firm-specific information (e.g., employer-reported job attributes), and 4) variations across industries (i.e., the presence of unions and industry profitability). The difficulty of finding suitable data for such empirical work still remains. Nevertheless, compensating differentials are

capable of being estimated and are particularly important for Air Force compensation policy.

3.4. Air Force Pilot Compensating Differentials: A Proposed Hedonic Model

The Air Force's low pilot retention rates indicate that pilots' wages are too low. Alternatively interpreted, low retention rates are also an indication that there are certain disagreeable job characteristics for which the Air Force pilot is not being compensated, or that the non-pecuniary benefits in the Air Force are inferior to those provided by the private sector.⁵⁰ This is confirmed by Air Force pilot exit surveys. In these surveys, military pilots frequently cite reasons other than low monetary wages for their decision to leave the Air Force. For example, in the 2000 Retention Survey Report, two-thirds of separating pilots believed the health benefits in the private sector were better than those in the Air Force; none considered military health benefits superior (Hamilton and Datko 2000, 10). More than two-thirds of them believed they would work fewer hours per week in a civilian job (compared to only 4 percent who believed they would work more) and 42 percent believed they would not be away from their families as often (compared to only 16 percent who believed they would be away more often) (10-11). Undoubtedly, there are characteristics associated with flying for the military that are unpleasant. As an example, the operations tempo (i.e., the number of temporary deployments and assignments away from home) is a disagreeable job attribute which may require additional compensation. Also, if one type of aircraft were less safe to fly than another,

⁵⁰ Or, alternatively, that there are positive job characteristics or fringe benefits in the civilian airline occupation that are not matched by similar occupations in the Air Force.

this hazard would require additional compensation. Thus, while low retention can ultimately be traced back to an inadequate monetary wage offered to Air Force pilots, solutions to increasing retention are not restricted to increasing monetary compensation. Some of the undesirable job characteristics could be minimized as an alternative to increasing monetary compensation. This is where a hedonic pricing model might be helpful in developing appropriate policies to promote pilot retention in the Air Force. If increasing pilot retention can be accomplished by offering low-cost amenities or reducing undesirable job characteristics, the Air Force might find it more cost-effective to do this in lieu of paying pilots higher monetary wages. If such characteristics cannot be changed cost-effectively, higher wages may be necessary.

Another important component of the theory of compensating differentials and hedonic pricing is its application to human capital. As shown in Chapter 2, human capital differences (i.e., training differences across aircraft) lead to varying retention rates. These rates could be equalized using the same principles described above. In this case, compensating differentials could serve as "equalizing differences" across various aircraft. Of course, there may be aircraft-specific characteristics (such as relative flying safety) independent of human capital issues which require compensating differentials. As an example, consider the difference in job attributes associated with a B-2 pilot and the pilot of Air Force One. The B-2 pilot's flying duties may require long, stressful missions in a cramped, uncomfortable cockpit. In contrast, the pilot of Air Force One may find flying the presidentially-tailored Boeing 747 a delightful job with low occupational safety risk and many side benefits (e.g., knowing the President and his staff). While human

capital variations exist between these two pilots, other factors unrelated to human capital variations may require additional compensation.

Rather than follow in the methodological footsteps of previous empirical work on hedonic prices and compensating wage differentials, my proposed hedonic wage model focuses on variations in retention rates rather than variations in wages as the dependent variable. Most previous models estimate the log of the wage rate (or earnings) as a function of job characteristics and individual demographic data.⁵¹ The problem with using this approach is that there is little variation among the wages of military pilots, and those wage variations which do exist are almost exclusively predetermined by the established wage structure (as highlighted in Chapter 1 above). Rather than estimating compensating differentials this way, my model uses and expands upon an approach first employed by Solnick, Henderson, and Kroeschel (1991). Their model incorporates attrition rates “as a proxy for the disutility of a job” (123). Following this approach, Model 1 estimates the compensation required to maintain a “steady-state” retention rate across aircraft categories. For example, fighter pilots have consistently lower retention rates than tanker pilots. This variance in retention can be explained by human capital variations, or by variances in job attributes from one aircraft category to another. Whatever the reason, if the Air Force desires to keep retention rates for all aircraft at the level of, say, fighter pilot retention rates, this model can estimate the compensating wage differential required to achieve this retention rate. Similar estimates can be made for

⁵¹ Or the models employ the change in the (log of the) wage rate as the dependent variable, for reasons identified above.

variations in deployment rates and job safety. Specific proposed models are found below.

3.5. Theoretical Model: Compensating Differentials for Human Capital Variances

The following outline of the theoretical model follows the discussion of Solnick, Henderson, and Kroeschel (1991, 125-126). In keeping with the approach used in Chapter 2, pilots may make a decision to remain in the military ($R_i = 1$) or quit ($R_i = 0$) when their active duty service commitment first expires. Each pilot makes his decision based upon the principle of utility-maximization. A pilot can derive utility indirectly from the income (which is used to consume utility-producing goods and services) earned as an Air Force pilot or as a civilian pilot. The pilot is retained if the value of civilian employment, minus the cost of switching employment, is less than the value of remaining in the military. Hence,

$$(3.1) \quad R_i = f(V_{Ai}, V_{Ci}, C_i)$$

Many factors influence the cost of switching job. Let the cost of switching be a function of the individual's stock of human capital (K_i), individual demographic characteristics—such as an overseas assignment—(X_i), the unemployment rate faced by each pilot at the decision point (U_i), and other individually-matched economic variables (G_i) identified in Chapter 2. Thus,

$$(3.2) \quad C_i = g(K_i, X_i, U_i, G_i).$$

Workers derive utility from wages (or income: Y_i) and non-wage benefits or job attributes (Z_i): $V_{Ai}, V_{Ci} = h(Y_i, Z_i)$. Combining this and (3.2) with (3.1) yields:

$$(3.3) \quad R_i = f(Y_i, K_i, Z_i, X_i, U_i, G_i)^{52}$$

Based on equation (3.3), we can run a logistic regression by applying the general model from Chapter 2 for each aircraft category j :

$$(3.4) \quad R_{ij} = \alpha + \beta Y_{ij}^* + \delta K_{ij} + \gamma X_{ij} + \lambda U_{ij} + \psi G_{ij} + \phi Z_{ij} + \varepsilon_{ij}$$

where Y_{ij}^* is the *net*⁵³ present discounted value of an Air Force pilot's lifetime income (in contrast to the *relative* measure used in Chapter 2) and K_{ij} now includes all human capital variables except aircraft type.

Applying this to Tanker aircraft (subscript T), the index from this logistic regression is:

$$(3.5) \quad I_T = \beta_0 + \beta_1 Y^*_T + \beta_2 K_T + \beta_3 Z_T + \beta_4 X_T + \beta_5 U_T + \beta_6 G_T$$

and $P_T = \frac{e^{I_T}}{1 + e^{I_T}}$ where P_T = the probability that $R_i = I$ (probability of being retained).

Therefore: $\frac{\partial P_T}{\partial Y^*_T} = P_T(1 - P_T)\beta_1 \equiv \alpha_1 > 0$ (as the net Air Force income increases, the retention probability rises).

⁵² Notice the similarity between equation 3.3 and equation 2.4 from the previous chapter:

$$(2.4) \quad R_i = \alpha + \beta Y_{R_i} + \delta K_i + \phi Z_i + \gamma X_i + \lambda U_i + \psi G_i + \mu_i$$

⁵³ Rather than use a relative measure: $Y_{R_i} = \frac{PDV_{AF}}{PDV_{CIV}}$ we now use a net measure:

$Y_{ij}^* = PDV_{AF} - PDV_{CIV}$. Because the relative measure is no longer used, PDV_{AF} and PDV_{CIV} were adjusted for inflation using the consumer price index.

From the logistic regression, we can retain the estimated retention probabilities for each individual. These retention probabilities (R_T) can then be used to run an ordinary least squares regression, with R_T as the dependent variable regressed as a function of the independent variables employed in the logistic regression. Simplifying, we can use the parameters from this OLS regression to calculate:

$$(3.6) \quad R_T = \alpha_0 + \alpha_1 \bar{Y}^*_T,^{54}$$

where \bar{Y}^*_T is the average net income for tanker pilots. Let R_f be the target retention rate (e.g., fighter pilot retention rate) where $R_T < R_f$. Then

$$(3.7) \quad R_f = R_T = \alpha_0 + \alpha_1(\bar{Y}^*_T + D_T)$$

where D_T is the compensating differential necessary to increase the probability of retention.

Solving for D_T :

$$(3.8) \quad \begin{aligned} (\bar{Y}^*_T + D_T) &= \frac{(R_T - \alpha_0)}{\alpha_1} \\ D_T &= \frac{(R_T - \alpha_0)}{\alpha_1} - \bar{Y}^*_T > 0 \end{aligned}$$

This procedure can be repeated for each aircraft to “equalize” the probability of retention across all aircraft types.

⁵⁴ All other independent variables are embedded in α_0 here to simplify the presentation.

3.6. Compensating Differentials for Human Capital Variances: Empirical Estimates

The results of the logistic and ordinary least squares regressions for each aircraft are summarized in Appendix D. Following the approach used in Chapter 2, separate regressions were run using three different discount rates in the calculation of the present discounted value of net Air Force income: 6 percent, 12 percent, and 18 percent. Table 3.1 provides an introductory example of how much additional compensation would be required to raise the average retention rate by 10 percent for each aircraft category.⁵⁵

Table 3.1: Additional Bonuses (Increase Average Retention by 10%)

Aircraft Category (Retention Rate: 1985-1999)							
	BMB (63.9 %)	FTR (60.0 %)	HELO (86.0 %)	SAL (38.9 %)	TAL (49.9 %)	TKR (47.0 %)	TRN (51.6 %)
6%	\$61,124	\$49,039	\$148,332	\$73,964	\$40,364	\$61,616	\$70,191
12%	\$17,147	\$15,914	\$35,796	\$21,990	\$12,912	\$17,635	\$20,314
18%	\$11,089	\$10,382	\$20,374	\$12,287	\$8,511	\$10,823	\$12,312

The average retention rate for fighter pilots is 60 percent. Using this retention rate as a target retention rate for all aircraft categories, we can identify compensating differentials for varying aircraft categories. These compensating differentials thus reflect disagreeable (or agreeable) job attributes, using fighter aircraft as the standard, for which additional (or less) compensation is necessary to maintain the same retention rates as fighter aircraft. Helicopter pilots, because of their unusually high retention rates compared to fixed wing aircraft pilots, have been left out of the table. Their

⁵⁵ Example: Bomber pilots had a retention rate of 63.9 percent during the 1985-1999 time period. The proposed bonuses reflect the additional compensation required to increase this rate to 73.9 percent.

compensating differentials would not be very useful because their high retention rates imply that they are significantly overpaid compared to other pilots. Yet in many respects, these pilots are in a category all by themselves and comparisons between their occupation and other pilots are not particularly meaningful. The compensating differentials for the remainder of the aircraft categories are listed below in Table 3.2:

Table 3.2: Compensating Differentials: Target Retention Rate of 60.0%

Aircraft Category (Retention Rate: 1985-1999)						
	BMB (63.9 %)	FTR (60.0 %)	SAL (38.9 %)	TAL (49.9 %)	TKR (47.0 %)	TRN (51.6 %)
6%	-\$23,592	\$0	\$156,233	\$41,098	\$80,340	\$59,443
12%	-\$6,618	\$0	\$46,449	\$13,146	\$22,994	\$17,204
18%	-\$4,280	\$0	\$25,954	\$8,665	\$14,113	\$10,427

It is important to note the sensitivity of the size of the bonus to changes in discount rates. Consider the strategic airlift aircraft in Table 3.2. If a 6 percent discount rate is assumed, it is necessary to offer a retention bonus of \$156,233—this amounts to approximately at 20 percent lifetime salary increase at this discount rate. In contrast, if an 18 percent discount rate is assumed, the bonus necessary to increase retention to 60 percent is only \$25,954—approximately a 9.5 percent increase in lifetime salary at an 18 percent discount rate. Clearly then, the size of the bonus offered to pilots is heavily dependent upon the assumed discount rate. This in turn has important implications for any policy decisions; such policy decisions should carefully consider the realism of any presumed discount rates.

3.7. Theoretical Model: Compensating Differentials for TEMPO and SAFETY Rate Variations

The same essential approach can be used to estimate the necessary compensation required for high TEMPO rates. Anecdotal evidence from Air Force pilots suggests that high TEMPO rates deter retention. Increases in TEMPO, as a form of job stress, must be compensated with either additional non-wage benefits or additional monetary compensation.

This model follows a procedure similar to the one above. The general differences are as follows. First, the entire pooled data set is regressed (like in the Chapter 2 regression model), rather than regressions for each aircraft type. Second, the relative lifetime income variable ($\frac{Y_{AF}}{Y_{CIV}}$) is used once again. Assuming steps 1 and 2 from Model 1 above, we can formally describe the model as follows:

The logit index is:

$$(3.9) \quad I = \beta_0 + \beta_1 \left(\frac{Y_{AF}}{Y_{CIV}} \right) + \beta_2 OPT + \dots$$

The marginal effects of a change in the wage or TEMPO are:

$$(3.10) \quad \frac{\partial P}{\partial \left(\frac{Y_{AF}}{Y_{CIV}} \right)} = P(1 - P)\beta_1 \equiv \lambda < 0 \quad \text{and} \quad \frac{\partial P}{\partial OPT} = P(1 - P)\beta_2 \equiv \theta > 0$$

To calculate the probability of retention for a pilot i :

$$(3.11) \quad P = \frac{e^I}{1 + e^I} \quad \text{where } P = \text{the probability that } R_i = 1$$

Simplifying, we can use the parameters from the logistic regression to calculate:

$$(3.12) \quad R = \omega + \lambda \left(\frac{\overline{Y_{AF}}}{\overline{Y_{CIV}}} \right) + \theta \overline{OPT},$$

where $\left(\frac{\overline{Y_{AF}}}{\overline{Y_{CIV}}} \right)$ is the average relative lifetime income and \overline{OPT} is the average TEMPO

rate. The goal is to maintain a steady-state retention rate (\bar{R}). This can be achieved through compensating differentials for changes in TEMPO. Let X_1 be the percent change in TEMPO and X_2 be the corresponding percent change in the relative wage to compensate for the increased stress level. To maintain a constant retention probability, this would require:

$$(3.13) \quad \lambda \left(\frac{\overline{Y_{AF}}}{\overline{Y_{CIV}}} \right) * X_1 + \theta (OPT * X_2) = 0$$

Simplifying yields:

$$(3.14) \quad \left(\frac{\overline{Y_{AF}}}{\overline{Y_{CIV}}} \right) * X_1 = - \left(\frac{\theta(\overline{OPT} * X_2)}{\lambda} \right)$$

$$(3.15) \quad X_1 = - \frac{\left(\frac{\theta(\overline{OPT} * X_2)}{\lambda} \right)}{\left(\frac{\overline{Y_{AF}}}{\overline{Y_{CIV}}} \right)}$$

Because X_1 is the percent increase in the relative lifetime discounted income, it must be multiplied by the discounted lifetime military income to get the military compensating differential (D) for increases in TEMPO:

$$(3.16) \quad X_1 * Y_{AF} = - \left(\frac{\theta(\overline{OPT} * X_2)}{\lambda} \right) * Y_{CIV} \equiv D$$

Ceteris paribus, D provides the compensating differential necessary for maintaining the average retention rates as the TEMPO changes. The same model may be used to estimate compensating differentials for variances in flying safety by simply substituting SAFETY for TEMPO.

3.8. Empirical Results

Table 3.3 below provides the results of the compensating differential estimation for variations in TEMPO rates, once again according to discount rates of 6 percent, 12

percent, and 18 percent. The percent change in TEMPO rates are based upon the mean TEMPO rate during the period (which was 5.18), and the compensating differentials are based upon the mean relative income during the period.

Table 3.3 TEMPO Compensating Differentials

	TEMPO increase of 10%	TEMPO increase of 50%	TEMPO increase of 100%
Compensating Differential @ 6%	\$8,505	\$42,527	\$85,054
Compensating Differential @ 12%	\$4,094	\$20,472	\$40,943
Compensating Differential @ 18%	\$2,452	\$12,260	\$24,519

Like Model 1, as the assumed discount rate increases, the size of the necessary compensating differential falls. The estimated compensating differentials are very sensitive to the assumed discount rate. Furthermore, it is important to note that the value of these estimates is dependent upon the accuracy of the proxy used for TEMPO in this dissertation. It would be preferable to use individual data indicating the number of days each pilot is deployed. In 2000, the Air Force began tracking the number of days each service member is deployed. This is in response to the complaints of high TEMPO rates in recent years. In fact, the Air Force has implemented a policy to provide additional compensation for those individuals who have high deployment rates. The current compensatory rule is that individuals receive \$100 per day for each day they are deployed in excess of 400 days, counted out of the previous two years.⁵⁶ This is clearly an effort by the Air Force to compensate its members for a disagreeable job attribute: high

⁵⁶ <http://www.xo.hq.af.mil/xoo/xooa/tempo/index.html>

deployment rates. Indeed, without such compensation, other perverse effects (such as low retention rates) will inevitably result.

Table 3.4 below depicts the compensating differentials required for changes in aircraft safety. In the logistic regressions, SAFETY was only statistically significant with a discount rate of 6 percent. Nevertheless, compensating differentials for variances in aircraft safety have been listed for each discount rate. Notably, relative safety does not appear to be a particularly important determinant in pilot retention. Indeed, variances in safety do not necessitate substantial compensating differentials. This could reflect the fact that flying tends to be a safe occupation and that many aircraft are designed to allow the pilot(s) to eject safely in the event of a catastrophic failure in flight. Some aircraft, such as the C-20, have no recorded Class A accidents during this time. Others, such as the F-16, have relatively high rates of aircraft accidents.⁵⁷ With these examples of compensating differentials in mind, it is now time to examine how to apply them by considering the insights of the economics of tournament theory.

Table 3.4: SAFETY Compensating Differentials

	Accident increase of 10%	Accident increase of 50%	Accident increase of 100%
Compensating Differential @ 6%	\$383	\$1,917	\$3,834
Compensating Differential @ 12%	\$134	\$670	\$1,339
Compensating Differential @ 18%	\$92	\$460	\$920

⁵⁷ The F-16 has a lifetime Class A accident rate of 4.3 accidents per 100,000 flying hours. In contrast, the Air Force average over the same time period (approximately 25 years) is only 1.94 accidents per 100,000 flying hours. See http://safety.kirtland.af.mil/AFSC/RDBMS/Flight/stats/aircraft_stats.html

3.9. Tournament Theory and the Structure of Compensation

One area of labor economics that is applicable to the structure of pay is known as tournament theory. Tournament theory posits that individuals competing for a promotion (i.e., advancement in a tournament) respond differently to different pay schemes. The intensity of effort by the participants in this tournament is a function of the expected return from their effort. Consider a tennis player in a tournament (see Rosen, 1986a, 702). A player expects the difficulty of his opponent to increase each time he advances to the next bracket; because good players generally advance and poor players are eliminated in early rounds, it is more difficult to advance in later rounds. The same holds true for promotions on the job. In an internal labor market with a hierarchical structure, as individuals advance within the company, the probability of being promoted to the next position generally falls. Promotion rates in the military reflect this: the percentage of lieutenants who are promoted to captain is much higher than the percentage of lieutenant colonels who are promoted to colonel. To encourage effort, rewards should be structured in such a way as to encourage continued advancement. Tournament theory thus offers a way to analyze and evaluate compensation systems and rewards as incentives. Lazear and Rosen accomplished much of the early work on tournament theory; they develop a complex model where they demonstrate that “wages based upon rank induce the same efficient allocation of resources as an incentive reward scheme based on individual output levels” (Lazear and Rosen 1981, 841). This is important because the cost of monitoring the productivity of each worker is prohibitively high for most firms—especially very large organizations like the Air Force. Because of this monitoring cost, it is important to

know whether or not a wage structure itself can yield the same efficient payments to labor that rewards based on marginal productivity can. Indeed, Lazear and Rosen demonstrate that such a pay scheme can be an efficient structure.

Subsequent research on tournament theory has been done by Green and Stokey (1983), O'Keefe, Viscusi, and Zeckhauser (1984), Rosen (1986a), and Bhattacharya and Guasch (1988). Green and Stokey (1983) expand on the earlier work of Lazear and Rosen, and contribute to the literature by examining more fully the implications of a risk-neutral principal employing risk-averse agents. They explain that when an individual's output varies according to a random shock, and when all individuals have the same random shock, a tournament can enable the principal to know the value of random shocks common to the group, and thus compensate its individual agents more efficiently. This is particularly important for large organizations:

In large groups, the rank order of an agent's observed output is a very accurate estimator of his output net of the common shock....it may be substantially easier to determine agents' rankings than to measure their output levels. (Green and Stokey 1983, 364)

Indeed, tournaments can be designed by a firm to mitigate the problems associated with asymmetric information and adverse selection, as the review of the internal labor market literature highlights above.

Rosen (1986a) expanded his previous research by demonstrating that individuals have a tendency to rest on their past achievements and reduce their work effort unless the top prize is disproportionately large. Thus, firms can create a very large "top prize" as an incentive for continued hard work by employees. Rosen summarizes:

The chief result is identifying a unique role for top-ranking prizes to maintain performance incentives in career and other games of survival. Extra weight on top-ranking prizes is required to induce competitors to aspire to higher goals independent of past achievements...If top prizes are not large enough, those that have succeeded in achieving higher ranks rest on their laurels and slack off in their attempts to climb higher. (Rosen 1986a, 713)

Asch and Warner (1994) apply this literature to their theory of military compensation.

The structure of pay can on the one hand provide incentives for individuals to work hard to achieve promotion to the next level, but if the pay is skewed too dramatically, this can lead one individual to expend effort seeking to sabotage the efforts of a competitor (Rosen 1992). Asch and Warner conclude that the current military pay system is insufficiently skewed to optimize the effort of military members. Indeed, to be most efficient and to provide the proper incentives, bonuses and compensating wage differentials should correspond to the ideas of tournament theory: compensation can be increasingly skewed if it is attached to rank. Such rank-dependent compensation encourages work effort.

The Air Force compensation system would be more efficient if it accounted for variations in retention rates across aircraft categories, variations in TEMPO rates, and differences in flying safety across different aircraft. Adjustments along these lines comport with the economic theory of compensating wage differentials. Additionally, to adapt to variations in these factors, it is necessary to maintain flexibility. Flexible bonuses might accomplish this. In addition to incorporating new compensating differentials, it is appropriate to consider the implications tournament theory has on the structure of military compensation. For example, Aviation Career Incentive Pay is not a

function of an individual's rank. It is only a function of an individual's years of aviation service. In order to provide an optimal incentive for hard work, it is fitting for ACIP to vary according to rank.

With these ideas in mind, let us turn to a hypothetical adjustment in the current compensation system. This adjustment accounts for variations in aircraft type and tournament theory. Because retention rates consistently vary according to aircraft type, one approach to constructing a more efficient compensation system is to structure the incentive pay according to aircraft category, with a structure consistent with tournament theory. Because ACIP was specifically instituted for the purpose of being an effective manpower tool for pilots, it does not make economic sense to employ a "one size fits all" ACIP when manpower needs vary across aircraft categories. Although target retention rates will inevitably vary according to the overall size, structure, and mission of the Air Force, let us assume for illustration purposes that the Air Force desires to stabilize retention rates across all aircraft categories with the average fighter pilot retention rate (60.0% from 1985-1999) as the target rate. In light of the estimates presented in Table 3.2 above, the pilots of several aircraft will require additional compensation. Suppose the prevailing discount rate is 12 percent. Strategic airlift pilots require the greatest additional compensation: approximately \$46,000.⁵⁸ Tactical airlift pilots require a modest \$13,000 additional compensation, and bomber pilots are actually overpaid by about \$6,600. These amounts are total present discounted values. Hence, ACIP could be

⁵⁸ See Table 3.2.

adjusted and tailored to each aircraft type in the following way. The current ACIP schedule is listed in Table 3.5 below.

Table 3.5: Current ACIP Schedule

Years of Aviation Service (YAS)	<2	>2	>3	>4	>6	>14	>22	>23	>24	>25
ACIP	\$125	\$156	\$188	\$206	\$650	\$840	\$585	\$495	\$385	\$250

This table already reflects a modestly skewed salary for those years in which the stay or leave decision is made by individual pilots. A substantial increase occurs at 6 years of aviation service and peaks between 14 and 22 years of service at \$840 per month. Economically, the inadequacies of this compensation table are at once apparent. First, it does not vary according to aircraft type. Second, there are no variations in ACIP according to rank. This creates perverse incentives for work effort, especially among those individuals who have achieved the rank of major (who can remain at this rank until retirement). In light of the preceding analysis, Table 3.6 below presents an alternative ACIP structure according to aircraft type only. Adjustments begin with 6 years of aviation service. For purposes of illustration, a discount rate of 12 percent is used.

Table 3.6: Recommended Increases in ACIP by Aircraft Category

Aircraft	YAS	6-10	11-15	16-20	PDV of ACIP Increase	Target Total Increase ⁵⁹
SAL		\$150	\$600	\$1,450	\$46,380	\$46,449
TAL		\$50	\$200	\$350	\$13,380	\$13,146
TKR		\$75	\$300	\$700	\$22,800	\$22,994

⁵⁹ These targets are taken from Table 3.2, using the discount rate of 12% from that table.

Notice that the increase is progressively skewed—as tournament theory recommends.

First, the ACIP increase during years 11 – 15 is four times higher than the ACIP increase given in years 6 – 10. This is followed by another increase in years 16 – 20 which can be even more than double the increase provided in years 11 – 15. Incorporating this into the current ACIP table results in the following:

Table 3.7: Skewed ACIP Schedule⁶⁰

Years of Aviation Service	6-10	11-13	14-15	16-20	21	>22	>23	>24	>25
Current:	\$650	\$650	\$840	\$840	\$840	\$585	\$495	\$385	\$250
ACIP: SAL	\$800	\$1,250	\$1,440	\$2,290	\$840	\$585	\$495	\$385	\$250
ACIP: TAL	\$700	\$850	\$1,040	\$1,190	\$840	\$585	\$495	\$385	\$250
ACIP: TKR	\$725	\$950	\$1,140	\$1,540	\$840	\$585	\$495	\$385	\$250

The skewed ACIP occurs through the twentieth year of aviation service. At this point, the ACIP reverts to its current rates. Typically, by the 21st year of aviation service an individual has either attained the rank of Colonel (and is thus eligible to continue in the tournament for promotions to higher ranks) or has been passed over and has little if any opportunity for further advancement in rank. More importantly, however, for the purposes of retention and work effort, the crucial incentive points occur around the ninth or tenth year of aviation service (when promotion opportunity from captain to major generally occurs) and the fourteenth or fifteenth year of aviation service (when promotion

⁶⁰ The first four steps of ACIP are not shown: \$125 for less than 2 years of aviation service, \$156 for less than 3 YAS, \$188 for less than 4 YAS, \$206 for less than 6 YAS.

opportunity from major to lieutenant colonel generally occurs). In light of tournament theory, the structured ACIP could be altered in a more efficient fashion. For example, if an individual receives the same ACIP regardless of rank, there is not as much of an incentive to work hard for promotion than there would be if ACIP were dependent upon rank. Consider a tanker pilot ACIP schedule, this time incorporating another application of tournament theory, where one pilot advances to the grade of lieutenant colonel while the other is passed over and remains a major:

Table 3.8: ACIP for Tanker Pilots

Years of Aviation Service	6-10	11-13	14-15	16-20	21	>22	>23	>24	>25
Current	\$650	\$650	\$840	\$840	\$840	\$585	\$495	\$385	\$250
ACIP (Rank)	\$725 (Capt)	\$950 (Maj)	\$1,140 (Maj)	\$1,860 (LtC)	\$960 (LtC)	\$705 (LtC)	\$615 (LtC)	\$505 (LtC)	\$370 (LtC)
ACIP (Rank)	\$725 (Capt)	\$950 (Maj)	\$1,140 (Maj)	\$1,380 (Maj)	\$630 (Maj)	\$375 (Maj)	\$285 (Maj)	\$175 (Maj)	\$40 (Maj)

Table 3.8 reflects a pay scale that incorporates: 1) additional compensation in light of the calculations presented in Table 2 to achieve a target retention rate of 60.0%, 2) it is more skewed in general as tournament theory recommends, and 3) it creates a tournament consistent with improving work effort by the pilots to attain the rank of lieutenant colonel.

3.10. Additional Considerations and Conclusion

There are several more important elements that should be noted in recommending an improved compensation system. First, the tables above present a static picture. Retention rates vary all the time according to the numerous factors presented in Chapter 2. As these retention rates vary, flexibility in compensation remains vitally important. Flexibility is probably most easily achieved through Aviator Continuation Pay—the pilot bonus which is currently limited to \$25,000 annually. Changes in ACIP tables are probably not as easily achieved. What is important, however, is that aviation career incentive pay be restructured to create a greater tournament effect for Air Force pilots. Perhaps a combination of a skewed adjustment of the ACIP table according to rank and aircraft category along with a flexible use of the ACP bonus tailored to the specific retention goals would be the most efficient and cost-effective approach.

CHAPTER 4: CONCLUSION

4.1 Pilot Retention and Institutional Economics

Air Force pilot manpower policy has made use of two primary tools to respond to low retention rates: 1) offering salary bonuses (Aviator Continuation Pay) or 2) increasing the active duty service commitment required of pilot training graduates. Recently, the Air Force increased the bonus to a maximum of \$25,000 annually, and also increased the active duty service commitment to its highest level ever: 10 years of service upon completion of pilot training. This dissertation has estimated the marginal effects of offering bonuses to pilots; clearly the bonus has had a substantial impact in persuading pilots to remain in the service. Further research is necessary to determine the consequences of increasing the active duty service commitment. Clearly this institutional tool is not without its economic costs in terms of discouraging potential pilots from entering pilot training; it may alter the quality of pilots choosing to proceed with UPT.

The Air Force has an institutional structure which is most accurately described as an internal labor market. It has a fairly rigid compensation structure, internal ports of entry, career paths, and wages attached to jobs. While this structure may be the most efficient means of training military personnel and providing "national defense," it cannot shield military personnel from external market forces. Because of this, it is worth

considering fundamental changes in compensation policy to make the Air Force more flexible in its ability to deal with fluctuating pilot retention rates.

4.2 Human Capital, Compensating Differentials, and Pilot Retention: A Recap

The regression analyses presented in Chapter 2 demonstrate that human capital variances are important factors in varying retention rates. This is especially true with flight hours, commissioning source, and whether or not the pilot is actually assigned to a flying job. More modest impacts are found across aircraft. Generally speaking, those pilots who fly aircraft that require skills which are easily transferable to the civilian airlines are more likely to separate from the Air Force than those whose flying skills are more Air Force-specific. If Air Force manpower requirements necessitate that retention rates to be roughly the same across aircraft categories, it makes economic sense to alter compensation according to aircraft category (i.e., to account for human capital variances).

Chapter 3 provided estimates of how much additional compensation would be required to maintain a targeted retention rate across all aircraft. To achieve a target of 60.0% retention (of those facing their first retention decision), this additional lifetime military compensation varied from \$156,233 for a strategic airlift pilot to an actual reduction in salary of \$23,592 for bomber pilots.⁶¹ A significant factor in estimating such compensating differentials is the assumed discount rate for the analysis. The lower the discount rate, the higher the additional compensation needed to increase retention rates. The reason for this is that the skewed civilian airline pay scales are relatively more

enticing the lower the discount rate is. Indeed, recommended compensation changes are highly sensitive to discount rate assumptions.

Although any specific compensation changes proffered in Chapter 3 are merely tentative examples, what is more clear are several general principles. First, stabilizing retention rates across aircraft necessitates aircraft-specific compensation adjustments. As retention rates vary, the use of bonuses *which vary according to aircraft type* (e.g., specific manpower needs according to aircraft) might provide the most flexibility, and thus be economically efficient. However, if retention rates consistently vary across aircraft, it is worth considering adjustments to the Aviation Career Incentive Pay schedules. Such adjustments could tailor ACIP to particular aircraft categories. Second, retention rates are heavily impacted by changes in TEMPO (according to the proxy used in this dissertation) but are not heavily impacted by variations in aircraft safety. Fortunately, the Air Force has recently begun providing compensation differentials for high TEMPO rates. This is a step in the right direction. Future research might examine more closely the relationship between non-wage amenities and retention rates, as well as how compensating differentials might be employed in the Air Force compensation system. Individual data would undoubtedly be more fruitful than some of the aggregate data used in this dissertation.

Third, it is important to incorporate the economics of tournament theory into compensation policy. Numerous studies, especially those from the RAND Corporation, have suggested that the Air Force's pay scale is insufficiently skewed. One proposal

⁶¹ At a 6 percent discount rate.

from the preceding analysis is to create a more highly skewed pay scale for pilots through the Aviation Career Incentive Pay. This is especially true, considering that pilots will have a ten-year service commitment upon completion of pilot training. Currently, pilots receive a significant increase in ACIP after six years of aviation service (an increase of \$444 per month). The next increase occurs at fourteen years of service and amounts to a mere \$190 per month increase. In the out years, ACIP actually *drops* for pilots. In light of tournament theory, the Air Force might reconsider its ACIP structure—especially considering the purported purpose of ACIP is to serve as a manpower tool to meet the military's demand for labor in particular occupational specialties (OSD 1996).⁶² Rather than providing a significant increase in pay at 6 years of aviation service, tournament theory suggests that ACIP should be progressively skewed especially at 10 years of aviation service (when future pilots will likely encounter their first opportunity to separate) and beyond (as an incentive for mid-level officers to remain in the military and provide optimum effort) and be tied to promotions in rank to provide proper incentives. Table 3.7 provides the outline of a suggested altered ACIP table (which also varies according to aircraft type) which is designed to provide incentives for mid-level officers (10 to 15 years of service) to remain in the military for a full twenty years.

This analysis of Air Force pilot retention has shown some remarkable empirical confirmation of the economic theory of human capital and its relationship to employee turnover. It has also yielded results not dissimilar to previous studies conducted in the economics of compensating differentials. With respect to human capital, the empirical

⁶² Page 198.

results are substantially consistent with economic theory. The more firm-specific the human capital, the more likely a pilot will remain in the Air Force. With respect to compensating differentials, the results are mixed. While TEMPO (as a proxy for job stress) is clearly a negative job attribute requiring additional compensation to maintain a targeted retention rate, unsafe aircraft do not appear to require such additional compensation. Nevertheless, human capital differences and job attributes variations are important factors in designing any compensation policy, as this analysis demonstrates.

APPENDICES

Appendix A: Descriptive Statistics

Retained Observations				Dropped Observations		
VARIABLE	MEAN	MIN	MAX	MEAN	MIN	MAX
R_i	0.5339	0	1	0.1886	0	1
YR6	0.7341	0.6209	1.3640	*	*	*
YR12	0.8058	0.6777	1.3845	*	*	*
YR18	0.9014	0.7405	1.6413	*	*	*
USAFA	0.3408	0	1	0.1751	0	1
OTS	0.2272	0	1	0.3316	0	1
ADVDEG	0.1579	0	1	0.2680	0	1
NOBACH	0.0074	0	1	0.0166	0	1
FLYJOB	0.9285	0	1	0.6728	0	1
FLTHRS	1904	0	6886.00	2313.79	0	9295
FTR	0.2880	0	1	0.3282	0	1
BMB	0.0563	0	1	0.1137	0	1
TRN	0.1652	0	1	0.1034	0	1
SAL	0.1632	0	1	0.1008	0	1
TAL	0.1072	0	1	0.0827	0	1
HELO	0.0473	0	1	0.0672	0	1
MISC	0.0074	0	1	0.1344	0	1
FEMALE	0.0259	0	1	0.0078	0	1
OS	0.1307	0	1	0.0955	0	1
MINB	0.0172	0	1	0.0185	0	1
MINO	0.0156	0	1	0.0132	0	1
MAR	0.7813	0	1	0.7878	0	1
SPOUSE	0.0465	0	1	0.0284	0	1
NFAM	1.5871	0	8	2.1343	0	9
MED	0.0224	0	1	0.0336	0	1
UNEMP	6.1023	4.3200	7.5100	6.3674	4.3200	7.5100
DRAW	0.1736	0	1	0.1731	0	1
HIRPELIG	10.9720	5.3476	28.8070	11.3860	5.3476	28.8070
AMEN	14609.1	12614.02	21448.01	14584.83	12614.02	21448.01
ACSAFE	13.8623	0	161.1344	14.7332	0	141.9782
TEMPO	5.1830	3.4745	11.0120	4.8639	3.4745	11.0120
PROMOTE	1.7704	1.3277	2.2931	1.7274	1.3277	2.2016
EXTEND	299.10	-688.0	2201.0	1714.5	-616	7736
	N = 14,165			N = differs for each variable		

* The relative wage is not calculable due to missing data (e.g., no data on number of dependents).

Appendix B: Relative Lifetime Income (YR) Calculation Methodology

This variable is calculated using the following assumptions:

1. PDV_{AF} is the calculated present discounted value of lifetime earnings for an individual who chooses to remain in the military until 20 years of service, retires from active duty, and then flies for the airlines until civilian retirement.
2. PDV_{CIV} is the calculated present discounted value of lifetime earnings for an individual who chooses to exit the Air Force and fly for the airlines until civilian retirement.
3. PDV_{AF} uses current year pay scales to calculate AF earnings profile, and assumes the individual receives Captain's pay from years 8 – 11, Major's pay from years 12 – 15, and Lt Col's pay from years 16 – 20 (typical promotion progression).
4. Discount rates of 6%, 12% and 18% are used in the calculations.[†]
5. Civilian retirement occurs at 60 years of age (mandatory retirement age for civilian pilots). Death occurs at 75.
6. PDV_{AF} is calculated with all allowances adjusted for their non-taxability at "conservative" tax rate of 15%. In other words, if a military officer receives \$1,000 per month in allowances, the tax-adjusted income calculated in PDV_{AF} is $\$1,000/.85 = \$1,176.47$.

[†] See Warner and Pleeter (2001) for evidence of high discount rates among military officers.

7. PDV_{CIV} uses average monthly earnings calculations provided by AIR, Inc. The average monthly earnings were compiled from the records of four air carriers which had continual reporting of earnings during this timeframe: American Airlines, Northwest Airlines, TransWorld Airlines, and United Airlines. These four airlines typically comprised 35 – 40% of all domestic airline traffic during this time period.
8. Three different military retirement systems were used from 1985 – 1999. Each of these different retirement systems was accounted for in our construction of the relative lifetime income variable.
9. Civilian airline retirement pay was estimated as follows:

$$\left(\sum_{t,y=1}^{60-AGE} \$SAL_{t,y} \right) (YOS - 3)(.01)$$

Where YOS = years of service flying for the airlines. This retirement pay is assumed to be given in a lump sum at retirement, and is discounted by the appropriate discount rate.

Appendix C: Relative Lifetime Earnings Example

Active Duty Pay							
Active Duty Base Pay (1995 Pay Chart) ¹ (\$CPT + \$MAJ + \$LTC)							
Rank	Years	Years of Commissioned Service				Σ PDV; i = 6%	
Captain	1995-1998	8-9	9-10	10-11	11-12	Active Duty Pay Total: \$495,650	
	Annual Pay:	\$47,536	\$47,536	\$49,553	\$49,553		
Major	1998-2002	12-13	13-14	14-15	15-16		
	Annual Pay:	\$55,528	\$55,528	\$57,511	\$57,511		
Lt Col	2002-2006	16-17	17-18	18-19	19-20		
	Annual Pay:	\$65,124	\$65,124	\$68,087	\$68,087		
Aviation Career Incentive Pay ² (\$ACIP)							
Years	Years of Aviation Service				Σ PDV; i = 6%		
1995 – 2005	8th Year through the 17th Year				ACIP Pay Total: \$68,470		
Annual ACIP Pay:	\$7,800 (\$650 per month)						
2005 – 2007	18th-19th Years						
Annual ACIP Pay:	\$7,020 (\$585 per month)						

¹ Pay rates assume the pilot has dependents. In this example, the pilot is eligible at age 31 with 8 years of commissioned service.² ACIP assumes the pilot's years of commissioned service exceed his years of aviation service by one year.

Appendix C (Continued)

Active Duty Pay (Continued): Aviator Continuation Pay ³ (\$BONUS)		
Years	Annual ACP	Σ PDV; $i = 6\%$
1995 – 2000	\$12,000	Discounted ACP Pay Total: \$71,000

For military retirement pay calculations, this example assumes the pilot was commissioned in January 1987 and retires in January 2007. This commissioning date puts the pilot under the “REDUX” retirement system. The example also assumes that the pilot is 43 years old at retirement and receives retirement income until his death at age 75.

Military Retirement Pay: REDUX System (\$MRET)		
Years	Annual Retirement Pay: (40% of “High 3” Lt Col’s base pay)	Σ PDV; $i = 6\%$
2007-2039	\$21,488	Discounted Retirement Pay Total: \$161,080

The discounted retirement pay discounts all the way back to the separation decision point (i.e., 8 years of service—or 12 years until the pilot begins to receive retirement pay).

³ ACP assumes the pilot accepts a \$12,000 annual bonus through the fourteenth year of service.

Appendix C (Continued)

Civilian Airline Pay: Post-Military Retirement (\$CIV)											
Pay ⁴ Category (Aircraft)	Years	Years of Civilian Airline Flying Service ⁵									
FE/FO	2007-09	1	2								Σ PDV; i = 6%
B727	Annual Pay:	\$23,874	\$35,174								
1 st Officer	2009-16	3	4	5	6	7	8	9	10		Civilian
B727	Annual Pay:	\$44,262	\$52,631	\$61,000	\$69,369	\$77,738	\$86,016	\$92,107	\$98,198		Airline
FO/CAPT	2016-24	11	12	13	14	15	16	17			Pay Total:
B727	Annual Pay:	\$102,534	\$106,870	\$111,206	\$115,542	\$119,878	\$124,214	\$128,550			\$421,010

Once again, this example discounts all the way back to the present—which means that the first year of civilian airline pay earned after military retirement (\$23,874) is discounted by a rate of 6 percent for 11 years (the number of years remaining until the pilot retires and begins his civilian airline career). Note that this is NOT the civilian salary that would be earned if the pilot separates at 9 years of commissioned service. That measure is shown below (\$SAL). FE = “Flight Engineer” FO = “First Officer.”

⁴ There may be some variation—this represents a “typical” career path.

⁵ This example continues the assumption that the pilot is 43 years old when he retires from the Air Force, whereupon he immediately begins flying for the airlines until he reaches the mandatory retirement age of 60.

Appendix C (Continued)

Civilian Airline Retirement Pay: Post-Military Retirement (CRET)			
Years Vesting in Retirement Plan	Retirement Years	Estimated "Lump Sum" Pay upon Retirement (60 years of age):	Σ PDV; i = 6% ("B" Plan)
2007 - 2024	2024-2039	\$1,449,163	Discounted Civilian Retirement Pay Total: \$37,443

From the above tables, we can calculate the estimated present discounted value of this pilot's income if he remains in the military until 20 years of service (the numerator in equation 2.1):

$$\begin{aligned}
 PDVAF = & \sum_{t_y=1}^{11-YOS} \frac{(\$CPT_{t,y})}{(1+r)^t} + \sum_{t_y=5}^{15-YOS} \frac{(\$MAJ_{t,y})}{(1+r)^t} + \sum_{t_y=9}^{20-YOS} \frac{(\$LTC_{t,y})}{(1+r)^t} = \$495,650 \\
 & + \sum_{t=1}^{ACIP_{Yrs}} \frac{(\$ACIP)}{(1+r)^t} + \sum_{t=1}^{BONUS_{Yrs}} \frac{(\$BONUS)}{(1+r)^t} = \$68,470 + \$71,000 = \$139,470 \\
 & + \sum_{t=75-AGE}^{75} \frac{(\$MRET_{t,y})}{(1+r)^t} = \$161,080 \\
 & + \sum_{t=20}^{60-AGE} \frac{(\$CIV_t)}{(1+r)^t} + \sum_{t=60}^{75} \frac{(\$CRET_{t,y})}{(1+r)^t} = \$421,010 + \$37,440 = \$458,450
 \end{aligned}$$

$$PDV_{AF} = \$495,650 + \$139,470 + \$161,080 + \$458,450 = \$1,254,650$$

Appendix C (Continued)

Civilian Airline Pay: Separate from the Air Force at 9 YOS (\$SAL) ⁶												
Pay ⁷ Category (Aircraft)	Years	Years of Civilian Airline Flying Service										Σ PDV $i = 6\%$
FE/FO	1995-1997	1	2									
B727	Annual Pay:	\$23,874	\$35,174									
1 st Officer	1997-2004	3	4	5	6	7	8	9				
B727	Annual Pay:	\$44,262	\$52,631	\$61,000	\$69,369	\$77,738	\$86,016	\$92,107				
FO/CAPT	2004-2010	10	11	12	13	14	15					
B727	Annual Pay:	\$98,198	\$102,534	\$106,870	\$111,206	\$115,542	\$119,878					
Captain	2011-16	16	17	18	19	20	21	22				
B727	Annual Pay:	\$124,214	\$128,550	\$132,886	\$137,222	\$141,149	\$145,894	\$150,230				
Captain	2016-2024	23	24	25	26	27	28	29				
B747	Annual Pay:	\$154,566	\$158,901	\$158,901	\$158,901	\$158,901	\$158,901	\$158,901	\$158,901	\$158,901	\$158,901	
Civilian Airline Pay Total:												\$1,340,780

⁶ According to this example, the pilot is 31 years old at separation. He flies for the civilian airlines for 29 years—until retirement at age 60.

⁷ There may be some variation—this represents a “typical” career path.

Appendix C (Continued)

Civilian Airline Retirement Pay: Post-Separation (CRET)			
Years Vesting in Retirement Plan	Retirement Years	Estimated "Lump Sum" Pay upon Retirement (60 years of age):	Σ PDV; i = 6% ("B" Plan)
1995-2024	2024-2039	\$3,264,931	Discounted Civilian Retirement Pay Total: \$156,670

From the above tables, we can calculate the estimated present discounted value of this pilot's income if separates from the Air Force at nine years of service (the denominator in equation 2.1) and then the relative discounted (at 6%) lifetime income:

$$\sum_{t,y=1}^{60-AGE} \frac{(\$SAL_{t,y})}{(1+r)^t} = \$1,340,780$$

$$+ \sum_{t=60}^{75} \frac{(\$CRET_{t,y})}{(1+r)^t} = \$156,670$$

$$PDV_{CIV} = \$1,340,780 + \$156,670 = \$1,497,450$$

$$Y_{RI} = \frac{PDV_{AIR}}{PDV_{CIV}} = \frac{\$1,254,650}{\$1,497,450} = 0.838$$

Appendix D: Human Capital Variances Regression Results

Table D.1: Bomber Aircraft						
Variable	Logistic Regression ⁸			OLS (P _i = Probability of Retention)		
	β (6%)	β (12%)	β (18%)	β (6%)	β (12%)	β (18%)
INTERCEPT	-6.780**	-1.921	-1.733	-0.913**	-0.100**	-0.025**
NETINC	0.100e ^{-4**}	0.409e ^{-4**}	0.682e ^{-4**}	0.164e ^{-3**}	0.583e ^{-3**}	0.902e ^{-3**}
USAFA	0.757**	0.736**	0.783**	0.110**	0.947e ^{-1**}	0.882e ^{-1**}
OTS	-0.220	-0.270	-0.194	-0.404e ^{-1**}	-0.457e ^{-1**}	-0.277e ^{-1**}
ADVDEG	0.2119	0.156	0.135	0.281e ^{-1**}	0.167e ⁻¹	0.136e ⁻¹
FLTHRS	-0.121e ^{-2**}	-0.154e ^{-2**}	-0.167e ^{-2**}	-0.198e ^{-3**}	-0.198e ^{-3**}	-0.197e ^{-3**}
FLYJOB	-0.508	-0.932*	-1.310**	-0.524e ^{-1**}	-0.913e ^{-1**}	-0.120**
OVERSEAS	-0.203	-0.179	-0.262	-0.298e ^{-1**}	-0.303e ⁻¹	-0.362e ⁻¹
MARSTAT	0.609	-0.112e ⁻¹	-0.656e ⁻¹	0.148e ⁻²	0.148e ⁻²	-0.431e ⁻²
MSPOUSE	0.234	0.200	0.297	0.553e ^{-1**}	0.452e ^{-1*}	0.486e ^{-1*}
NFAM	0.277e ⁻¹	-0.745e ⁻¹	-0.839e ⁻¹	-0.213 e ⁻²	-0.883e ^{-2*}	-0.783e ⁻²
MEDICAL	0.717	0.429	0.265	0.123**	0.840e ^{-1**}	0.492e ^{-1*}
UNEMP	2.125**	2.287**	2.200**	0.366**	0.344**	0.300**
DRAW	-2.353**	-3.195**	-3.564**	-0.347**	-0.418**	-0.429**
HIRPELIG	-0.143e ⁻¹	-0.464e ⁻¹	-0.636e ^{-1*}	-0.387e ^{-2**}	-0.862e ^{-2**}	-0.989e ^{-2**}
AMEN	0.160e ^{-3*}	-0.133e ⁻⁶	-0.395e ⁻⁴	0.370e ^{-4**}	0.113e ^{-4**}	0.539e ⁻³
SAFETY	-0.572e ⁻²	-0.772	-0.866e ⁻²	-0.114e ^{-2**}	-0.159e ^{-2**}	-0.186e ^{-2**}
TEMPO	-0.289**	-0.401**	-0.440**	-0.469e ^{-1**}	-0.562e ^{-1**}	-0.575e ^{-1**}
TEMPO*MAR	0.282e ⁻¹	0.185e ⁻¹	0.592e ⁻²	0.495e ^{-2*}	0.247e ⁻²	0.130e ⁻²
EXTEND	-0.249e ⁻³	-0.329e ⁻³	-0.874e ⁻⁴	-0.670e ^{-4**}	-0.929e ^{-4**}	-0.589e ^{-4**}
N = 798	LLF 6%: -380.7			R ² 6% = .952		
* = P < .05	LLF 12%: -329.1			R ² 12% = .920		
** = P < .01	LLF 18%: -292.6			R ² 18% = .904		

⁸ Logistic Regression calculates the individual retention probabilities which are then retained as the dependent variable in the OLS regression.

Appendix D (Continued)

Table D.2: Fighter Aircraft						
Variable	Logistic Regression			OLS		
	β (6%)	β (12%)	β (18%)	β (6%)	β (12%)	β (18%)
INTERCEPT	-3.726**	-0.469e ⁻¹	-0.665	-0.395**	0.189**	0.126**
NETINC	0.129e ^{-4**}	0.449e ^{-4**}	0.746e ^{-4**}	0.204e ^{-5**}	0.630e ^{-5**}	0.963e ^{-5**}
USAFA	0.368**	0.337**	0.365**	0.602e ^{-1**}	0.499e ^{-1**}	0.469e ^{-1**}
OTS	-0.580**	-0.541**	-0.429**	-0.116**	-0.110**	-0.842e ^{-1**}
ADVDEG	0.134	0.169	0.196	0.190e ^{-1**}	0.196e ^{-1**}	0.215e ^{-1**}
FLTHRS	-0.893e ^{-3**}	0.955e ^{-3**}	-0.928e ^{-1**}	-0.128e ^{-3**}	-0.110e ^{-3**}	-0.923e ^{-4**}
FLYJOB	-0.942**	-1.052**	-1.250**	-0.123**	-0.115**	-0.125**
OVERSEAS	0.361**	0.329**	0.303**	0.652e ^{-1**}	0.564e ^{-1**}	0.467e ^{-1**}
MARSTAT	-0.121	-0.327	-0.488	-0.312e ^{-1**}	-0.622e ^{-1**}	-0.808e ^{-1**}
MSPOUSE	0.278	0.332	0.370	0.615e ^{-1**}	0.637e ^{-1**}	0.670e ^{-1**}
NFAM	-0.106e ⁻¹	-0.605e ⁻¹	-0.663e ⁻¹	-0.109e ⁻²	-0.691e ^{-2**}	-0.550e ^{-2**}
MEDICAL	2.252**	2.480**	2.587**	0.241**	0.208**	0.188**
UNEMP	2.214**	2.409**	2.348**	0.380**	0.359**	0.319**
DRAW	-2.903**	-3.683**	-4.035**	-0.467**	0.516**	-0.518**
HIRPELIG	-0.168e ⁻²	-0.363e ^{-1**}	-0.542e ^{-1**}	-0.511e ⁻³	-0.679e ^{-2**}	-0.860e ^{-2**}
AMEN	-0.840e ^{-4*}	-0.259e ^{-3**}	-0.295e ^{-3**}	-0.596e ^{-5**}	-0.253e ^{-4**}	-0.274e ^{-4**}
SAFETY	-0.365e ⁻²	-0.227e ⁻²	-0.114e ⁻²	-0.557e ^{-3**}	-0.419e ^{-3**}	-0.305e ^{-3**}
TEMPO	-0.260**	-0.366**	-0.419**	-0.433e ^{-1**}	-0.535e ^{-1**}	-0.566e ^{-1**}
TEMPO*MAR	0.406e ⁻²	0.110e ⁻¹	0.177e ⁻¹	0.263e ⁻²	0.432e ^{-2*}	0.517e ^{-2*}
EXTEND	-0.651e ^{-3**}	-0.685e ^{-3**}	-0.464e ^{-3**}	-0.136e ^{-3**}	-0.151e ^{-3**}	-0.118e ^{-3**}
N = 4080	LLF 6%: -1974.5			R ² 6% = .946		
* = P < .05	LLF 12%: -1701.9			R ² 12% = .914		
** = P < .01	LLF 18%: -1518.4			R ² 18% = .899		

Appendix D (Continued)

Table D.3: Helicopter Aircraft						
Variable	Logistic Regression			OLS		
	β (6%)	β (12%)	β (18%)	β (6%)	β (12%)	β (18%)
INTERCEPT	1.813	6.368*	7.643**	0.769e ⁻¹	1.362**	1.466**
NETINC	0.909e ⁻³ **	0.358e ⁻⁴ **	0.638e ⁻⁴ **	0.674e ⁻⁶ **	0.279e ⁻³ **	0.491e ⁻³ **
USAFA	-0.446	-0.416	-0.343	-0.474e ⁻¹ **	-0.392e ⁻¹ **	-0.312e ⁻¹ **
OTS	-0.180	-0.118	-0.149e ⁻¹	-0.242e ⁻¹ **	-0.288e ⁻¹ **	-0.963e ⁻²
ADVDEG	0.176	0.110	0.778e ⁻¹	0.308e ⁻¹ **	0.330e ⁻¹ **	0.338e ⁻¹ **
FLTHRS	0.509e ⁻³	0.457e ⁻³	0.452e ⁻³	0.376e ⁻⁴ **	0.275e ⁻⁴ **	0.268e ⁻⁴ **
FLYJOB	-1.724*	-1.933*	-2.052**	-0.842e ⁻¹ **	-0.878e ⁻¹ **	-0.897e ⁻¹ **
OVERSEAS	-0.195e ⁻¹	-0.630e ⁻²	-0.264e ⁻¹	0.362e ⁻²	0.429e ⁻²	0.223e ⁻²
MARSTAT	-0.677	-0.879	-0.967	-0.808e ⁻¹ **	-0.109**	-0.118**
MSPOUSE	-0.181	-0.755e ⁻¹	0.175e ⁻¹	-0.220e ⁻¹ *	-0.729e ⁻²	0.457e ⁻²
NFAM	0.104	0.482e ⁻¹	0.312e ⁻¹	0.109e ⁻¹ **	0.621e ⁻² *	0.664e ⁻²
MEDICAL	1.165	1.074	1.024	0.715e ⁻¹ **	0.620e ⁻¹ **	0.547e ⁻¹ **
UNEMP	1.312**	1.436**	1.349**	0.119**	0.118**	0.983e ⁻¹ **
DRAW	-1.369*	-2.063**	-2.385**	0.111**	0.144**	-0.147**
HIRPELIG	0.201e ⁻¹	0.471e ⁻²	-0.725e ⁻²	0.683e ⁻² **	0.397e ⁻² **	0.202e ⁻² *
AMEN	-0.263e ⁻³ **	-0.452e ⁻³ **	-0.569e ⁻³ **	-0.434e ⁻⁴ **	-0.572e ⁻⁴ **	-0.635e ⁻⁴ **
SAFETY	-0.284e ⁻²	-0.274e ⁻²	-0.240e ⁻²	-0.171e ⁻³ *	-0.945e ⁻⁴	-0.889e ⁻⁵
TEMPO	-0.190e ⁻¹	-0.937e ⁻¹	-0.135	-0.969e ⁻³	-0.781e ⁻² *	-0.910e ⁻² *
TEMPO*MAR	0.336e ⁻¹	0.293e ⁻¹	0.135e ⁻¹	0.531e ⁻²	0.649e ⁻²	0.521e ⁻²
EXTEND	-0.256e ⁻³	-0.413e ⁻³	-0.275e ⁻³	-0.315e ⁻⁴ **	-0.489e ⁻⁴ **	-0.316e ⁻⁴ **
N = 670	LLF 6%: -223.5			R ² 6% = .845		
* = p < .05	LLF 12%: -206.4			R ² 12% = .776		
** = p < .01	LLF 18%: -192.7			R ² 18% = .759		

Appendix D (Continued)

Table D.4: Strategic Airlift Aircraft						
Variable	Logistic Regression			OLS		
	β (6%)	β (12%)	β (18%)	β (6%)	β (12%)	β (18%)
INTERCEPT	-9.881**	-7.363**	-7.617**	-1.413**	-0.947**	-0.843**
NETINC	0.931e ⁻³ **	0.330e ⁻⁴ **	0.602e ⁻⁴ **	0.135e ⁻³ **	0.455e ⁻³ **	0.814e ⁻³ **
USAF	0.626**	0.571**	0.541**	0.102**	0.889e ⁻¹ **	0.792e ⁻¹ **
OTS	-0.223	-0.183	-0.101	-0.279e ⁻¹ **	-0.251e ⁻¹ **	-0.142e ⁻¹ **
ADVDEG	0.383*	0.339*	0.344*	0.570e ⁻¹ **	0.522e ⁻¹ **	0.523e ⁻¹ **
FLTHRS	-0.585e ⁻³ **	-0.597e ⁻³ **	-0.555e ⁻³ **	-0.828e ⁻⁴ **	-0.780e ⁻⁴ **	-0.655e ⁻⁴ **
FLYJOB	-0.390	-0.337	-0.317	-0.589e ⁻¹ **	-0.488e ⁻¹ **	-0.425e ⁻¹ **
OVERSEAS	-0.180	-0.201	-0.194	-0.270e ⁻¹ **	-0.278e ⁻¹ **	-0.260e ⁻¹ **
MARSTAT	0.842e ⁻¹	0.100	0.162	0.208e ⁻¹ **	0.197e ⁻¹ *	0.181e ⁻¹ **
MSPOUSE	0.139	0.240	0.343	0.252e ⁻¹ **	0.350e ⁻¹ **	0.472e ⁻¹
NFAM	-0.453e ⁻²	-0.350e ⁻¹	-0.487e ⁻¹	-0.101e ⁻²	-0.479e ⁻² **	-0.554e ⁻² **
MEDICAL	1.716**	1.587**	1.460**	0.250**	0.219**	0.186**
UNEMP	2.254**	2.361**	2.335**	0.386**	0.372**	0.344**
DRAW	-2.017**	-2.456**	-2.768**	-0.331**	-0.362**	-0.384**
HIRPELIG	-0.534e ⁻¹ **	-0.893e ⁻¹ **	-0.115**	-0.959e ⁻² **	-0.137e ⁻¹ **	-0.157e ⁻¹ **
AMEN	0.146e ⁻³ **	0.444e ⁻⁴	0.696e ⁻³	0.307e ⁻⁴ **	0.159e ⁻⁴ **	0.770e ⁻⁵ **
SAFETY	0.986e ⁻²	0.113e ⁻¹	0.121e ⁻¹	0.114e ⁻² **	0.131e ⁻² **	0.150e ⁻² **
TEMPO	-0.234**	-0.288**	-0.319**	-0.385e ⁻¹ **	-0.428e ⁻¹ **	-0.446e ⁻¹ **
TEMPO*MAR	0.172e ⁻¹	-0.707e ⁻²	-0.348e ⁻¹	0.230e ⁻² **	-0.575e ⁻³	-0.303e ⁻²
EXTEND	-0.938e ⁻⁴	-0.255e ⁻³	-0.242e ⁻³	-0.195e ⁻⁴ **	-0.473e ⁻⁴ **	-0.490e ⁻⁴ **
N = 2312	LLF 6%: -1073.6			R ² 6% = .968		
* = P < .05	LLF 12%: -993.27			R ² 12% = .948		
** = P < .01	LLF 18%: -920.3			R ² 18% = .936		

Appendix D (Continued)

Table D.5: Tactical Airlift Aircraft						
Variable	Logistic Regression			OLS		
	β (6%)	β (12%)	β (18%)	β (6%)	β (12%)	β (18%)
INTERCEPT	-6.004**	-3.623**	-5.218**	-1.824**	-1.336**	-1.502**
NETINC	0.165e ⁻⁴ **	0.511e ⁻⁴ **	0.777e ⁻⁴ **	0.248e ⁻⁵ **	0.774e ⁻⁵ **	0.117e ⁻⁴ **
USAF	0.363*	0.267	0.274	0.664e ⁻¹ **	0.423e ⁻¹ **	0.352e ⁻¹ **
OTS	-0.549**	-0.403**	-0.242	-0.922e ⁻¹ **	-0.714e ⁻¹ **	-0.387e ⁻¹ **
ADVDEG	-0.222	-0.326	-0.297	-0.245e ⁻¹ **	-0.309e ⁻¹ **	-0.268e ⁻¹ **
FLTHRS	-0.300e ⁻³	-0.148e ⁻³	-0.973e ⁻⁴	-0.582e ⁻⁴ **	-0.313e ⁻⁴ **	-0.109e ⁻⁴ *
FLYJOB	-1.029**	-1.256**	-1.391**	-0.113**	-0.120**	-0.130**
OVERSEAS	-0.343*	-0.398*	-0.411*	-0.523e ⁻¹ **	-0.487e ⁻¹ **	-0.451e ⁻¹ **
MARSTAT	0.209	-0.116	-0.246	0.817e ⁻¹ **	0.223e ⁻¹	-0.141e ⁻¹ **
MSPOUSE	0.355	0.455	0.604	0.826e ⁻¹ **	0.808e ⁻¹ **	0.923e ⁻¹
NFAM	-0.147e ⁻¹	-0.762e ⁻¹	-0.854e ⁻¹	-0.380e ⁻²	-0.128e ⁻¹ **	-0.120e ⁻¹ **
MEDICAL	1.055*	0.629	0.387	0.171**	0.101**	0.668e ⁻¹ **
UNEMP	1.853**	1.775**	1.570**	0.319**	0.274**	0.223**
DRAW	-0.136	0.122	0.115	-0.191e ⁻¹	0.696e ⁻¹ **	0.981e ⁻¹ **
HIRPELIG	-0.731e ⁻¹ **	-0.131**	-0.150**	-0.115e ⁻¹	-0.211e ⁻¹ **	-0.235e ⁻¹ **
AMEN	-0.154e ⁻⁴	-0.117e ⁻³ *	-0.974e ⁻⁴	0.499e ⁻⁵ **	-0.104e ⁻⁴ **	-0.106e ⁻⁴ **
SAFETY	0.596**	0.788**	0.810**	0.931e ⁻¹ **	0.128**	0.136**
TEMPO	0.106	0.103	0.831e ⁻¹	0.210e ⁻¹ **	0.251e ⁻¹ **	0.240e ⁻¹ **
TEMPO*MAR	-0.926e ⁻¹	-0.544e ⁻¹	-0.433e ⁻¹	-0.223e ⁻¹ **	-0.140e ⁻¹ **	-0.903e ⁻² **
EXTEND	-0.793e ⁻³ **	-0.995e ⁻³ **	-0.756e ⁻³ **	-0.131e ⁻³ **	-0.176e ⁻³ **	-0.150e ⁻³ **
N = 1518	LLF 6%: -744.4			R ² 6% = .947		
* = P < .05	LLF 12%: -632.7			R ² 12% = .941		
** = P < .01	LLF 18%: -570.4			R ² 18% = .951		

Appendix D (Continued)

Table D.6: Tanker Aircraft							
Variable	Logistic Regression			OLS			
	β (6%)	β (12%)	β (18%)	β (6%)	β (12%)	β (18%)	
INTERCEPT	-9.169**	-5.803**	-5.906**	-1.247**	-0.574**	-0.510**	
NETINC	0.104e ^{-4**}	0.387e ^{-4**}	0.668e ^{-4**}	0.162e ^{-5**}	0.567e ^{-5**}	0.924e ^{-5**}	
USAFA	0.157	0.149	0.174**	0.293e-1**	0.255e ^{-1**}	0.258e ^{-1**}	
OTS	-0.681**	-0.672**	-0.578	-0.108**	-0.134**	-0.841e ^{-1**}	
ADVDEG	0.538**	0.564**	0.608**	0.858e ^{-1**}	0.858e ^{-1**}	0.861e ^{-1**}	
FLTHRS	-0.825e ^{-3**}	-0.945e ^{-3**}	-0.972e ^{-3**}	-0.126e ^{-3**}	-0.131e ^{-3**}	-0.126e ^{-3**}	
FLYJOB	-1.169**	-1.180	-1.249**	-0.152**	-0.130**	-0.124**	
OVERSEAS	0.257	0.177	0.113	0.493e ^{-1**}	0.393e ^{-1**}	0.295e ^{-1**}	
MARSTAT	0.382	0.242	0.188	0.464e ^{-1**}	0.918e ⁻²	-0.154e ⁻¹	
MSPOUSE	-0.250	-0.124	-0.532e ⁻¹	-0.319e ^{-1**}	-0.107e ⁻¹	0.430e ⁻²	
NFAM	0.361e ⁻¹	-0.251e ⁻¹	-0.490e ⁻¹	0.802e ^{-2**}	-0.191e ⁻³	-0.149e ⁻²	
MEDICAL	0.950*	0.662	0.445	0.148**	0.989e ^{-1**}	0.662e ^{-1**}	
UNEMP	2.190**	2.323**	2.240**	0.380**	0.364**	0.326**	
DRAW	-1.879**	-2.499**	-2.820**	-0.308**	-0.372**	-0.391**	
HIRPELIG	-0.775e ^{-1**}	-0.116**	-0.139**	-0.137e ^{-1**}	-0.175e ^{-1**}	-0.187e ^{-1**}	
AMEN	0.269e ^{-3**}	0.153e ^{-3**}	0.119*	0.487e ^{-4**}	0.262e ^{-4**}	0.196e ^{-4**}	
SAFETY	-0.476e ^{-1**}	-0.493e ^{-1**}	-0.500**	-0.861e ^{-2**}	-0.776e ^{-2**}	-0.654e ^{-2**}	
TEMPO	-0.188**	-0.261**	-0.292**	-0.349e ^{-1**}	-0.433e ^{-1**}	-0.461e ^{-1**}	
TEMPO*MAR	-0.856e ⁻¹	-0.888e ⁻¹	-0.103	-0.125e ^{-1**}	-0.103e ^{-1**}	-0.939e ^{-2**}	
EXTEND	-0.503e ⁻⁴	-0.163e ⁻³	-0.274e ⁻⁴	-0.448e ^{-4**}	-0.755e ^{-4**}	-0.480e ^{-4**}	
N = 2342	LLF 6%: -1129.1			R ² 6% = .960			
* = P < .05	LLF 12%: -1007.5			R ² 12% = .939			
** = P < .01	LLF 18%: -914.4			R ² 18% = .929			

Appendix D (Continued)

Table D.7: Trainer Aircraft

Variable	Logistic Regression			OLS		
	β (6%)	β (12%)	β (18%)	β (6%)	β (12%)	β (18%)
INTERCEPT	-7.396**	-4.134**	-4.705**	-1.199**	-0.658**	-0.617**
NETNC	0.106e ^{-4**}	0.384e ^{-4**}	0.655e ^{-4**}	0.142e ^{-5**}	0.492e ^{-5**}	0.812e ^{-5**}
USAF	0.292*	0.309*	0.338*	0.503e ^{-1**}	0.508e ^{-1**}	0.509e ^{-1**}
OTS	-0.403**	-0.362*	-0.307*	-0.685e ^{-1**}	-0.681e ^{-1**}	-0.545e ^{-1**}
ADVDEG	0.367*	0.360*	0.372*	0.550e ^{-1**}	0.501e ^{-1**}	0.551e ^{-1**}
FLTHRS	-0.673e ^{-3**}	-0.602e ^{-3**}	-0.544e ^{-3**}	-0.121e ^{-3**}	-0.111e ^{-3**}	-0.100e ^{-3**}
FLYJOB	-0.110	-0.241	-0.360	0.194e ^{-1**}	0.254e ^{-1**}	0.291e ^{-1**}
OVERSEAS	0.790	0.604	0.514	0.138**	0.107**	0.899e ^{-1**}
MARSTAT	0.316e ⁻¹	-0.171	-0.300	0.999e ⁻²	-0.208e ⁻¹	-0.408e ^{-1**}
MSPOUSE	0.131e ⁻¹	0.193e ⁻¹	0.142e ⁻¹	0.683e ⁻²	0.874e ⁻²	0.133e ^{-1*}
NFAM	0.106	0.628e ⁻¹	0.420e ⁻¹	0.189e ^{-1**}	0.128e ^{-1**}	0.102e ⁻¹
MEDICAL	0.866*	0.900*	0.961*	0.126**	0.114**	0.112**
UNEMP	2.079**	2.228**	2.194**	0.367**	0.354**	0.324**
DRAW	-1.922**	-2.564**	-2.892**	-0.290**	-0.343**	-0.368**
HIRPELIG	-0.520e ^{-1**}	-0.859e ^{-1**}	-0.109**	-0.973e ^{-2**}	-0.139e ^{-1**}	-0.152e ^{-1**}
AMEN	0.992e ^{-4*}	-0.455e ⁻⁴	-0.725e ⁻⁴	0.310e ^{-4**}	0.132e ^{-4**}	0.716e ^{-3**}
SAFETY	-0.706e ⁻²	-0.501e ⁻¹	-0.400e ⁻²	-0.149e ^{-2**}	-0.137e ^{-2**}	-0.132e ^{-2**}
TEMPO	-0.233**	-0.319**	-0.369**	-0.386e ^{-1**}	-0.462e ^{-1*}	-0.498e ^{-1**}
TEMPO*MAR	-0.340e ⁻¹	-0.269e ⁻¹	-0.236e ⁻¹	-0.608e ^{-2**}	-0.375e ⁻²	-0.222e ⁻²
EXTEND	-0.211e ⁻³	-0.376e ^{-3*}	-0.274e ⁻³	-0.445e ^{-4**}	-0.799e ^{-4**}	-0.690e ^{-4**}
N = 2340	LLF 6%: -1153.8			R ² 6% = .960		
* = P < .05	LLF 12%: -1029.9			R ² 12% = .924		
** = P < .01	LLF 18%: -932.5			R ² 18% = .911		

REFERENCE LIST

- Adelman, Irma and Zvi Griliches. 1961. "On an Index of Quality Change." *Journal of the American Statistical Association* 56, no. 295: 535-548.
- Alchian, Armen and Harold Demsetz. 1972. "Production, Information Costs, and Economic Organization." *American Economic Review* 62, no 5: 777-795.
- Antel, John J. 1986. "Human Capital Investment Specialization and the Wage Effects of Voluntary Labor Mobility." *The Review of Economics and Statistics* 68, no 3: 477-483.
- Asch, Beth. 1993. *Designing Military Pay: Contributions and Implications of the Economics Literature*. Santa Monica: RAND Corporation.
- Asch, Beth, Richard Johnson, and John T. Warner. 1998. *Reforming the Military Retirement System*. Santa Monica: RAND Corporation.
- Asch, Beth and John Warner. 1994. *A Theory of Military Compensation and Personnel Policy*. Santa Monica: RAND Corporation.
- _____. 1995. *A Policy Analysis of Alternative Military Retirement Systems*. Santa Monica: RAND Corporation.
- _____. 1999. *Separation and Retirement Incentives in the Civil Service*. Santa Monica: RAND Corporation.
- Ash, Colin, Bernard Udis, and Robert F. McNown. 1983. "Enlistments in the All-Volunteer Force: A Military Personnel Supply Model and Its Forecasts." *American Economic Review* 73, no 1: 145-155.
- Atrostic, B.K. 1982. "The Demand for Leisure and Nonpecuniary Job Characteristics." *American Economic Review* 72, no. 3: 428-440.
- Barrows, Stephen P. 1993. *Air Force Pilot Retention: An Economic Analysis*. Masters Paper. The Pennsylvania State University.
- Becker, Gary S. 1962. "Investment in Human Capital: A Theoretical Analysis." *Journal of Political Economy* 70, no. 5: 9-49.

- Bhattacharya, Sudipto, and J. Luis Guasch. 1988. "Heterogeneity, Tournaments, and Hierarchies." *Journal of Political Economy* 96, no. 4: 867-881.
- Black, Matthew, Robert Moffitt, and John Warner. 1990. "The Dynamics of Job Separation: The Case of Federal Employees." *Journal of Applied Econometrics* 5, no. 3: 245-262.
- Blakemore, Arthur, Stuart Low, and Michael Ormiston. 1987. "Employment Bonuses and Labor Turnover." *Journal of Labor Economics* 5, no. 4: S124-S135.
- Brown, Charles. 1980. "Equalizing Differences in the Labor Market." *Quarterly Journal of Economics* 94, no. 1: 113-134.
- Buddin, Richard J. 1999. *Building a Personnel Support Agenda*. Santa Monica: RAND Corporation.
- Campbell, Carl M. 1997. "The Determinants of Dismissals, Quits, and Layoffs: A Multinomial Logit Approach." *Southern Economic Journal* 63, no. 4: 1066-1073.
- Carretta, Thomas R. 2000. "U.S. Air Force Pilot Selection and Training Methods." *Aviation Space and Environmental Medicine* 71, no. 9:950-956.
- Caudill, Steven B. 1988. "An Advantage of the Linear Probability Model over Probit and Logit." *Oxford Bulletin of Economics and Statistics* 50, no. 4: 425-427.
- Coase, Ronald. 1937. "The Nature of the Firm." *Economica* (November): 386-405.
- Darby, Kit, and Dan Gradwohl. *Major Airline Salary Survey*. 1995-1996. Atlanta: Aviation Information Resources, Inc.
- _____. *Major Airline Salary Survey*. 1996. Atlanta: Aviation Information Resources, Inc.
- _____. *U.S. Airlines Salary Survey*. 1997-1998. Atlanta: Aviation Information Resources, Inc.
- Department of the Air Force, Directorate of Cost and Management Analysis, *The Air Force Budget*. Fiscal Year 1987-1990/91. Washington D.C.
- Department of the Air Force, Office of the Deputy for Cost and Economics, *United States Air Force Statistical Digest*. 1992-1999. Washington D.C.
<<http://www.saffm.hq.af.mil/>>

- Department of the Air Force, Air Force Instruction 91-204, *Safety Investigations and Reports*. 2001. Washington D.C.
< <http://afpubs.hq.af.mil/pubfiles/af/91/afi91-204/afi91-204.pdf>>
- DeVany, Arthur, and Thomas Saving. 1982. "Life-Cycle Job Choice and the Demand and Supply of Entry Level Jobs: Some Evidence from the Air Force." *Review of Economics and Statistics* 64, no. 3: 457-465.
- Doeringer, Peter B. 1986. "Internal Labor Markets and Noncompeting Groups." *American Economic Review* 76, no. 2: 48-52.
- Doeringer, Peter, and Michael Piore. 1971. *Internal Labor Markets and Manpower Analysis*. (Lexington: D.C. Heath and Company).
- Duncan, Greg, and Bertil Holmlund. 1983. "Was Adam Smith Right After All? Another Test of the Theory of Compensating Wage Differentials." *Journal of Labor Economics* 1, no. 4: 366-379.
- Eberts, Randall, and Joe Stone. 1995. "Wages, Fringe Benefits, and Working Conditions: An Analysis of Compensating Differentials." *Southern Economic Journal* 52, no. 1: 274-280.
- Elliott, Robert, and Robert Sandy. 1998. "Adam Smith May Have Been Right After All: A New Approach to the Analysis of Compensating Differentials." *Economics Letters* 59, no. 1: 127-131.
- Flanagan, Robert J. 1974. "Labor Force Experience, Job Turnover, and Racial Wage Differentials." *Review of Economics and Statistics* 56 (November):521-529.
- . 1978. "Discrimination Theory, Labor Turnover, and Racial Unemployment Differences." *Journal of Human Resources* 13, no. 2: 187-207.
- French, Michael, and Laura Dunlap. 1998. "Compensating Wage Differentials for Job Stress." *Applied Economics* 30, no. 8: 1067-1075.
- Fullerton, Richard L. 2000. *An Empirical Assessment of United States Air Force Pilot Retention*. The Mershon Center, The Ohio State University.
- Future Aviation Professionals of America. *Pilot Salary Survey*. 1984-1994. Decatur, Georgia.
- Gradwohl, Dan, and Kit Darby. *U.S. Airlines Salary Survey and Career Earnings Comparison*. 1998. Atlanta: Aviation Information Resources, Inc.

- _____. *U.S. Airlines Salary Survey and Career Earnings Comparison*. 1999-2000. Atlanta: Aviation Information Resources, Inc.
- Green, Jerry and Nancy Stokey. 1983. "A Comparison of Tournaments and Contracts." *Journal of Political Economy* 91, no. 3: 349-364.
- Hamilton, Charles and Louis Datko. 2000. "Report on Career Decisions in the Air Force: Results of the 2000 USAF Careers and New Directions Survey." Department of the Air Force: Air Force Personnel Center.
- Hashimoto, Masanori. 1979. "Bonus Payments, on-the-Job Training, and Lifetime Employment In Japan." *Journal of Political Economy* 87, no. 5:1086-1104.
- _____. 1981. "Firm-Specific Human Capital as a Shared Investment." *American Economic Review* 71, no. 3: 475-482.
- Hersch, Joni. 1989. "Another Look at Compensating Differentials." *Journal of Behavioral Economics* 18, no. 1: 41-50.
- Jovanovic, Boyan. 1979a. "Job Matching and the Theory of Turnover." *Journal of Political Economy* 87, no. 5: 972-990.
- _____. 1979b. "Firm Specific Capital and Turnover." *Journal of Political Economy* 87, no. 6: 1246-1260.
- Kumar, Pradeep, and Mary Coates. 1982. "Occupational Earnings, Compensating Differentials, and Human Capital: An Empirical Study." *Canadian Journal of Economics* 15, no. 3: 442-457.
- Lancaster, Kelvin J. 1966. "A New Approach to Consumer Theory." *Journal of Political Economy* 74, no. 2: 132-157.
- Lazear, Edward, and Sherwin Rosen. 1981. "Rank-Order Tournaments as Optimum Labor Contracts," *Journal of Political Economy* 89, no. 5: 841-864.
- Long, James E. 1982. "Are Government Workers Overpaid? Alternative Evidence." *Journal of Human Resources* 17, no. 1: 123-131.
- Long, James and Albert Link. 1983. "The Impact of Market Structure on Wages, Fringe Benefits, and Turnover." *Industrial and Labor Relations Review* 36, no. 2: 239-250.

- Long, Rebecca and Arthur Bedeian. 1998. "Internal Labor Markets: Labor-Process and Market-Power Effects." *Advances in Industrial and Labor Relations*. Stamford: JAI Press.
- Lucas, Robert E. B. 1975. "Hedonic Price Functions." *Economic Inquiry* 13, no. 2: 157-178.
- . 1977. "Hedonic Wage Equations and Psychic Wages in the Returns to Schooling." *American Economic Review* 67, no. 4: 549-558.
- McLaughlin, Kenneth J. 1991. "A Theory of Quits and Layoffs with Efficient Turnover." *Journal of Political Economy* 99, no. 1: 1-29.
- Office of the Secretary of Defense. 1996. *Military compensation background papers: Compensation elements and related manpower cost items*, 5th ed. Washington, D.C.
- Mises, Ludwig von. 1983. *Bureaucracy*. New Haven: Yale UP, 1944. Reprint, Grove City: Libertarian Press (page references are to the reprint edition).
- Montgomery, Edward, Kathryn Shaw, and Mary Benedict. 1992. "Pensions and Wages: An Hedonic Price Theory Approach." *International Economic Review* 33, no. 1: 111-128.
- O'Keefe, Mary, W. Kip Viscusi, and Richard Zeckhauser. 1984. "Economic Contests: Comparative Reward Schemes." *Journal of Labor Economics* 2, no. 1: 27-56.
- Oswald, Andrew J. 1984. "Wage and Employment Structure in an Economy with Internal Labor Markets." *Quarterly Journal of Economics* 99, no. 4: 693-716.
- Parsons, Donald O. 1972. "Specific Human Capital: An Application to Quit Rates and Layoff Rates." *Journal of Political Economy* 80, no. 6: 1120-1143.
- Pettypiece, Card. n.d. Web page containing aviation information. University of Western Ontario. <http://www.csd.uwo.ca/~pettypi/elevon/gustin_military/db/>
- Rosen, Sherwin. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy* 82, no. 1: 34-55.
- . 1986a. "Prizes and Incentives in Elimination Tournaments." *American Economic Review* 76, no. 4: 701-715.
- . 1986b. "The Theory of Equalizing Differences." *Handbook of Labor Economics*,

- ed. O. Ashenfelter, vol 1. Amsterdam: North Holland.
- _____. 1988. "Transaction Costs and the Internal Labor Market," *Journal of Law, Economics and Organization* 4, no. 1: 49-64.
- _____. 1992. "The Military as an Internal Labor Market: Some Allocation, Productivity, and Incentive Problems." *Social Science Quarterly*, 73, no. 2: 227-237.
- Smith, Adam. 1981. *An Inquiry into the Nature and Causes of the Wealth of Nations*, vol. 1, Oxford: Clarendon Press, 1979. Reprint, Indianapolis: Liberty Classics, (page references are to the reprint edition).
- Solnick, Loren. 1988. "Promotion, Pay, Performance Ratings, and Quits." *Eastern Economic Journal* 14, no. 1: 51-62.
- Solnick, Loren, David Henderson, and Joseph Kroeschel. 1991. "Using Quit Rates to Estimate Compensating Differentials in the Military." *Defence Economics* 2, no. 2: 123-133.
- Stone, Brice, Vince Wiggins, Kathryn Turner-Holland, and Larry Cooper. 1998. "Air Force Pilot Retention: Evaluating the Results of Alternative Models," *Armed Forces & Society* 25, no. 1: 121-135.
- Taylor, William, S. Craig Moore, C. Robert Roll. 2000. *The Air Force Pilot Shortage: A Crisis for Operation Units?* Santa Monica: RAND Corporation.
- Thie, Harry, William Taylor, Claire Levy, Clifford Graf, and Sheila Kirby. 1995. *Total Force Pilot Requirements and Management*. Santa Monica: RAND Corporation.
- Wachter, Michael, and Randall Wright. 1990. "The Economics of Internal Labor Markets." *Industrial Relations* 29, no. 2: 240-262.
- Warner, John T. 1978. "The Prediction of Attrition from Military Service." Arlington: Institute of Naval Studies.
- Warner, John, and Beth Asch. 1995. "The Economics of Military Manpower." *Handbook of Defense Economics*. eds. K. Hartley and T. Sandler, vol. 1 Amsterdam: North-Holland.
- Warner, John. and Saul Pleeter. 2001. "The Personal Discount Rate: Evidence from Military Downsizing Programs." *American Economic Review* 91, no. 1: 33-54.
- Weiss, Andrew. 1984. "Determinants of Quit Behavior." *Journal of Labor Economics* 2, no. 3: 371-387.

- Williamson, Oliver E. 1975. *Markets and Hierarchies: Analysis and Antitrust Implications*. New York: The Free Press.
- _____. 1981. "The Economics of Organization: The Transaction Cost Approach." *American Journal of Sociology* 87, no. 3: 548-577.
- Woodbury, Stephen A. 1983. "Substitution between Wage and Nonwage Benefits." *American Economic Review* 73, no. 1: 166-182.